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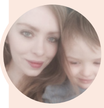

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editor's letter

ISSUE 24

I write these words in the immediate aftermath of the latest abomination to emanate from Donald Trump: his appalling racist references to Haiti, African nations and El Salvador. The news cycle will have moved on by the time this magazine makes its way into your hands, spanning countless Trumpian horrors in between. Such is his obsession with ratings, it's as if Trump confuses being talked about with being liked. That said, although his approval ratings are at a historic low for a new US president, it is a shock to me that he still has the backing of over a third of voters. The last couple of years have truly been a chastening lesson in public opinion. The world is becoming a smaller, frightened, insular place, where the focus is too often on difference, on building walls and borders.

However tiny our impact might be relative to this global shift, it's gratifying to be fighting that trend. Therefore, I am extremely pleased to be able to report that Easca, a non-profit Irish sustainable building association I co-founded a long time ago, is merging with the AECB, the UK's largest sustainable building association. At a time when so much talk is of divorce between the UK and its European partners, this new relationship will provide an opportunity to foster and build relationships between Irish and British people united by a shared commitment to good building. Climate change, like so many of the existential environmental threats that we face this century, knows no borders. Nor should we, if we are to give ourselves a fighting chance of keeping the world habitable in the coming decades.

Humour me and think on this for a moment. Whatever kind of building it is that you're focusing on now – whether you're the client, designer, planner, builder or supplier – try and picture that building in 30, 60 or 100 years time. Is it still standing? Is it still in use? Does it need to be retrofitted by new owners – real flesh and blood people who may seem little more than abstract concepts now – who look at this building as the manifestation of a generation who knew about climate change and environmental damage yet weren't sufficiently troubled to do anything about it? Was the consideration and care that went into the decision-making, the design and the workmanship sufficiently good enough to ensure it endures as a positive contribution to the world that you helped to make?

These may seem like lofty concerns, far removed from the worries of real people struggling in the moment, given no option in the face of rising land prices and a metastasising housing crisis with immediate, painful, shameful human consequences. Of course building sustainably would be lovely: it's just not realistic right now. But that would be wrong. Such a notion pre-supposes that sustainable building must be harder, more expensive, and with benefits back loaded at a time when the focus is on the here and now. But while it's true that sustainable building is beneficial in the long term, it also brings immediate benefits. It's not about short term pain for long term gain. Luckily, the things you need to do to create a building fit for the rigours of the coming decades offer benefits from day one, and potentially at little or no upfront cost. After all, who doesn't want to live in a building that is always comfortable, light, airy and all without having to worry about the next energy bill?

Finally, I'd like to thank my old friend and colleague Steve Molyneux, who left our company after our last issue. Steve: you were a pleasure to work with, and we'll miss you.

Regards,
The editor

About
Passive House Plus is an official partner magazine of The Association for Environment Conscious Building, The International Passive House Assocation and The Passivhaus Trust.

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The prebiotic passive house

As understanding grows of the importance to human health of good bacteria in our environment, and new hospitals in the US start to undergo 'prebiotic' treatment, Dr Peter Rickaby asks how long it will be before microbiology becomes a core part of building design.

My last column here was retrospective, so it seems appropriate to be more speculative this time, and look to the future of sustainable buildings. Where might we be going and where are the pitfalls?

I have been encouraged by the burgeoning success of the passive house standard in the UK and Ireland, during the last three years. It is undoubtedly the best strategy for designing and constructing energy efficient small buildings, and it is being embraced by more architects who are persuading their clients to use the passive house approach to make sustainable architecture.

It is pointing the way to a robust, scientifically-based method of meeting the EU requirement for near zero energy buildings (nZEBs). However, I am uneasy about the zealotry exhibited by some adherents of passive house, who seem to think that Wolfgang Feist is the one true God and PHPP is his word.

There may be some merit in this view, but I am reminded of Catherine Nixey's excellent, witty book about the way in which the early Christians treated the Greek, Roman and Egyptian 'philosophers' (i.e. thinkers, scholars and teachers) after the conversion of the Emperor Constantine to Christianity. The Christians demanded only blind faith, and the philosophers' rational questioning was intolerantly and often brutally suppressed, setting the development of science back by a thousand years.

The comparison with passive house zealotry is perhaps a little strong, but we do need to continue to think about how to make energy efficient, sustainable buildings, and not cling to ideas when they become inappropriate. For example, I find the notion of high-rise office buildings built to the passive house standard absurd – just because they are passive doesn't make them sustainable, and a large office building has a huge carbon footprint in the transport sector. We shouldn't be building them, passive house or not.

Another issue is adherence to MVHR – great in new houses but not necessarily the best option for an Enerphit retrofit of a Victorian terraced house, a 1930s semi-detached house or a 1960s flat. MVHR is quite primitive, more sophisticated approaches to ventilation are emerging (e.g. demand control) and we should be prepared to embrace them.

Another book, one that opened my eyes to possibilities for future buildings, is Ed Yong's account of the 'biome' – the invisible community of 3.9 trillion microbes that live on and in all our bodies, and on and in every other living thing, as well as on every surface around us and in all our buildings .

> How long before we have microbiologists on our project teams, pre-configuring internal biomes to make them healthy?

We each have our own community of microbes, which we share with our colleagues, families and pets, and the microbial communities in our homes are unique to our individual households. Microbes are everywhere – on every wall and floor, every door-handle, every work surface.

Keeping our built environments healthy is not about keeping them sterile – devoid of microbes, which is almost impossible – but about ensuring that the microbial communities are dominated by benign species that contribute positively to our ecology and keep malignant species at bay.

In health care, individuals can be given 'prebiotic' doses of good bacteria to bring their biomes back into balance, and so, it turns out, can buildings. Simply opening a window admits good microbes from the soil and air outside that re-balance communities of internal microbes and help to suppress the malign species that can accumulate and make us ill.

So, is sealing our buildings and supplying filtered 'fresh' air through ventilation systems necessarily a good thing? It might be appropriate when the external air quality is poor – because of PM10 pollution for example — but elsewhere microbiology offers a new approach to sick building syndrome.

Already, new hospitals in the US have been given prebiotic treatment before occupation, to ensure that the internal microbial ecology will be benign and suppress malign species. Similar treatment of new homes, to suppress pathogens, remove microbes that don't suit us, and provide precisely-tailored biomes to support our families' health, cannot be far away.

We argue now about how to ventilate passive houses, but how long will it be before we have microbiologists on our project teams, pre-configuring internal biomes to make them healthy for us?

I think we can be sure that the passive house approach to building design is of its time, and coming of age. But the sustainable buildings of the not too distant future will be so unlike the ones we are building today that we may hardly recognise them. ■

Dr Peter Rickaby is an energy and sustainability consultant working in the building and housing industries. He is a Trustee of the National Energy Foundation, a member of the Each Home Counts Implementation Board and chairs the BSI Retrofit Standards Task Group. The views expressed here are his own.


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eHAUS PACIFIC, NEW ZEALAND

This rustic holiday home, set near the town of Twizel against the stunning backdrop of New Zealand's Southern Alps, was built as a holiday home for a young family from Auckland eager to have a base for exploring the outdoors.

The clients had approached eHaus, NZ passive house design and construction experts, who delivered the project together with Ben and Jessica Eyers of Hiberna Design & Build and their team.

"They wanted good connection to the outdoors, plenty of storage and overflow sleeping space for family and friends, hard-wearing durable finishes, a big mud room for wet and muddy gear, and a warm comfortable efficient space," write Ben and Jessica Eyers.

The two firms worked closely together to create a "simple energy efficient house that was hard-wearing but none the less outstanding in its performance".

The walls and roof of the house were built with prefabricated structural insulated panels (SIPs) that were insulated with mineral wool. The timber windows, meanwhile, were locally made by Theradura, and frame stunning views of the surrounding mountains.

"One of the main challenges was the wind," says Ben Eyers. The house sits in one of the highest wind zones in New Zealand, meaning extra structural timber was needed to cope with the wind load.

And though it doesn't quite meet the passive house standard, it was designed using the key principles of passive house design — insulation, airtightness and heat recovery ventilation — using the passive house software PHPP, and has passive-level airtightness of just 0.46 air changes per hour.

"While on site installing the ventilation system the outside temperature fell to 1C but the inside house temperature was sitting at 23C," says Baden Brown, director of eHaus. "It was a such a great reflection of the performance of the insulation and airtightness."

"We wanted simplicity, robustness, a safe harbour from the elements, that accommodates groups of people to share great experiences," homeowner Hadley Slade-Jones told NZ House & Garden magazine.

The whole team seem to have achieved just that.

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THE HOUSE AT CORNELL TECH, NEW YORK CITY

Completed in the summer of 2017, the 26-storey House at Cornell Tech — built to provide accommodation for students of the engineering institute on Roosevelt Island in New York City — is now the tallest certified passive building in the world.

A cornerstone of Cornell Tech's proposal when it won a competition to build a new technology campus on the island was to make it as sustainable and energy efficient as possible.

But one of the biggest early challenges for the House was getting it through a public design review, which was essential seeing as the project is on city-owned land. At first, the design commission was keen for the building to be entirely clad in glass — not ideal for meeting the insulation requirements of the passive house standard.

"Getting the design commission on board for something that deviated from the standard playbook for a Manhattan apartment building was the most challenging part of the process," says Andrew Winters, director of capital projects at Cornell Tech. "Those are not the easiest conversations to have."

Eventually, the team convinced the commission that a mostly-opaque facade would be better both in terms of aesthetics and energy efficiency. The House was thus built with a cast-in-place concrete frame filled in with prefabricated metal panels, with windows installed and made airtight in the factory.

Making the whole building airtight was still a big challenge, particularly with a construction crew that weren't used to the rigours of the passive house standard. An airtightness consultant was appointed early on to train the construction workers, who were required to alert a supervisor if the airtight barrier was punctured. "We told them that they weren't going to passive house prison, but how important it was to let someone know if they made a mistake so we could repair it," says Louis Schwartz of contractor Monadnock Construction.

Another big challenge was the question of how to ventilate the 352 apartments. Passive houses typically have heat recovery ventilation units — which use warm, outgoing stale air to pre-heat incoming fresh air — but installing a separate system in each dwelling here would have added $1.5m to the overall budget. Instead, the design team were able to procure two large customised units that sit near the top of the building, with ducting traveling from there to each dwelling.

Meanwhile, each apartment is heated and cooled by a low-energy 'variable refrigerant flow' heat pump — essentially an air conditioner that can also work in reverse and provide heating too.

The building finished construction in June 2017, ahead of schedule and within budget. It has been passive house certified by the Wicklow-based Passive House Academy.

Project architects Blake Middleton and Deborah Moelis write: "For the entire team, this project has been a successful beta test to meet our moral imperative to minimise the carbon footprint of buildings. It's our answer to the call for making big and meaningful change to combat global warming."


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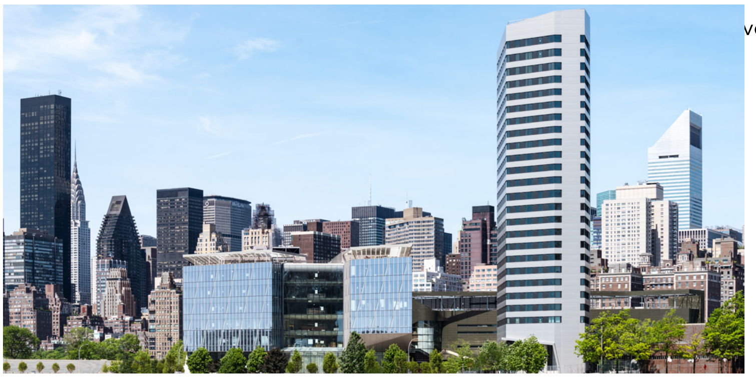

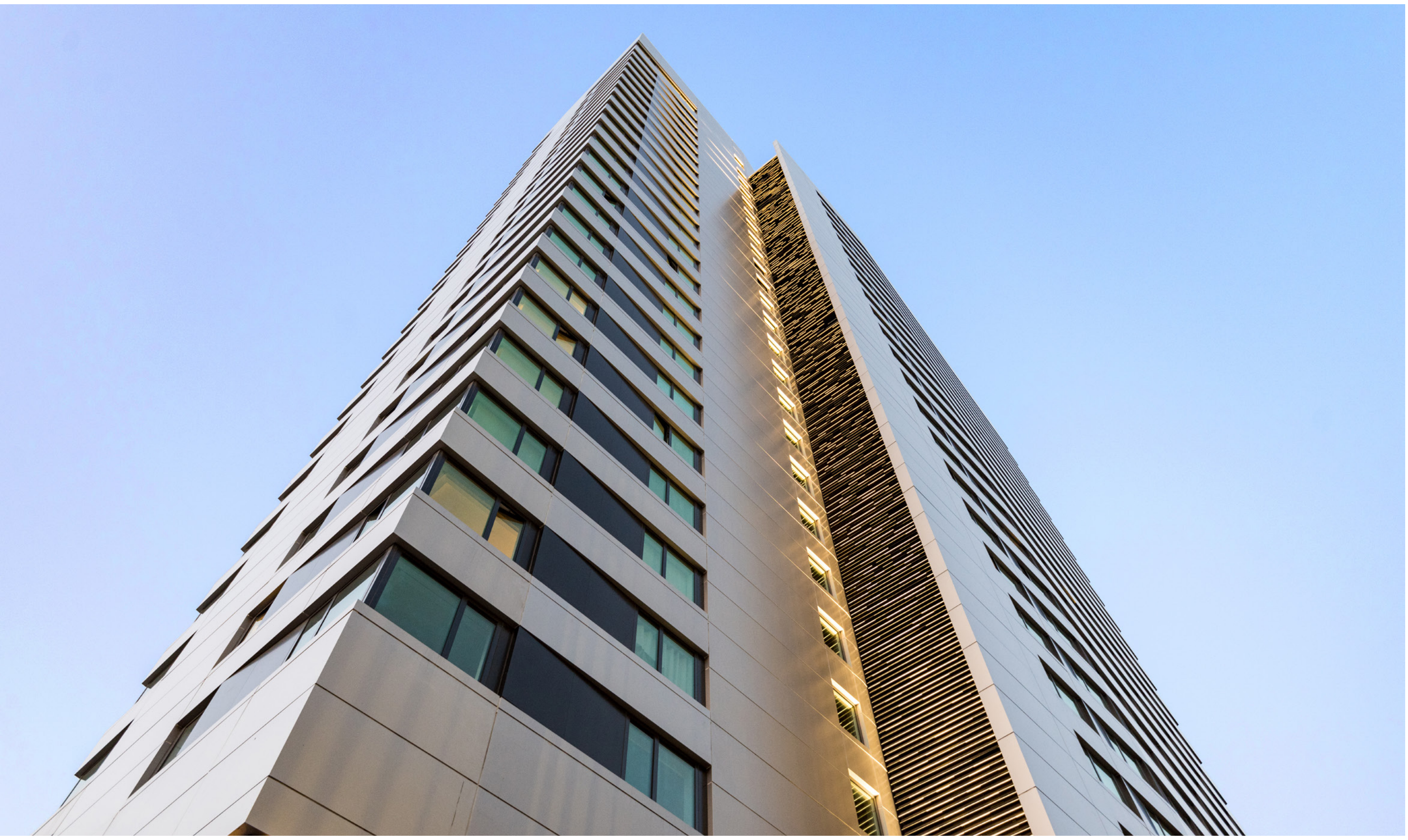

NEWS

New passive secondary school in Sutton gets green light

A major new £36m secondary school in Sutton, designed by passive architecture specialists Architype, has successfully received planning permission.

The school is part of the wider masterplan for the intended London Cancer Hub (LCH), a new life science innovation cluster focused on cancer research and treatment, situated on the former Sutton Hospital site.

The brief for the school, developed by the London Borough of Sutton and the Harris Federation, seizes the opportunity to integrate secondary school pupils into the campus's wider remit of scientific research and treatment. The building will be of cross-laminated timber with a concrete frame.

In keeping with the overall masterplan, the design of the new school aims to inspire pupils to pursue a career within life sciences, supported by the expertise, innovation and influence of the surrounding research facilities.

Continuing the Borough's reputation for high-quality development, a key integration has been environmental sustainability, with an ambition to achieve both passive house and Breeam Excellent certification.

The central spine of the four-storey school is interposed by alternating wings to balance the mass of the 10,600 sqm school, which will accommodate up to 1,275 pupils and 95 staff.

Willmott Dixon have been named as the successful contractor for the project and the project team are now developing the detailed design. The project starts on site at the end of the year, with completion due in 2019.

Architype director, Ben Humphries said: "We have worked hard to maintain a rigorous ecological approach while navigating the complex site constraints and we are delighted to have received planning permission for this groundbreaking project. We look forward to working with London Borough of Sutton, Harris Federation and Willmott Dixon to deliver an exemplary school environment and the first entire passive house secondary school in the UK." ■

(above) Illustrations of Architype's passive house-designed four-storey secondary school in Sutton, which is due to start on site by the end of 2018.

UK & Irish green building associations merge

The Environmental and Sustainable Construction Association (Éasca) is merging with the Association for Environment Conscious Building (AECB), the two organisations have announced.

Founded in 1989, the AECB is the largest sustainable building-related membership organisation in the UK. Éasca was established in 2004 by prominent green architects Paul Leech, Prof Tom Woolley and Duncan Stewart , along with Passive House Plus editor Jeff Colley.

Writing to to Éasca members in a joint statement, AECB CEO Andy Simmonds and Jeff Colley said: "We believe that the charter and mutual goals of the two associations are so well aligned that this new cooperation will be of significant benefit to both you and the sector. We are very much looking to this exciting new chapter for both Éasca and AECB members."

Éasca members have been invited to become AECB members, including a plethora of member benefits. Members can avail of a Passive House Plus subscription, networking opportunities and a range of discounts to events and the AECB's pioneering Carbonlite training courses, which consist of new build and retrofit training.

Éasca members will be provided with a dedicated area on the AECB website, which will be launched in early 2018. ■

UKGBC & AECB call for government to act on green rhetoric

Two of the UK's leading sustainable building organisations have cautiously welcomed Theresa May's 11 January speech on the environment, and the publication of the government's 25 year environment plan. But while acknowledging the government's new effort to focus on the environment, both the UK Green Building Council and the Association for Environment Conscious Building insisted the plan would be meaningless without strong action to back it up.

According to AECB CEO Andy Simmonds: "The government shows in the elegant introduction to its 25 year plan that it understands what is needed to build a greener future." Simmonds warned that while government may be starting to make the right noises on the environment, that doesn't necessarily mean the right policies. "Action speaks louder than words, and there are precious few commitments to action. It is also worth taking note of what is not addressed: the plan is alarmingly quiet on the subject of fracking, to give just one example."

"It is very encouraging that the prime minister has chosen to focus on the importance of protecting and restoring our environment in a major speech," said UKGBC chief executive Julie Hirigoyen. "The 25 Year Plan contains some positive commitments to improving our built environment, with a target to embed an 'environmental net gain' principle for development and ensure high environmental standards for all new build housing. But, as many have noted, this plan is not legislation. We need these commitments to be reflected in the upcoming review of building regulations and an ambitious Environment Act."

Given the urgency and seriousness of the environmental challenge, Simmonds called for politicians to reach across the aisles in pursuit of solutions. "The scale – and time frame – of the challenge demands cross party collaboration. Our future depends on the use of rigorous environmental science, with technical and community expertise brought in to ensure plans succeed in practice."

"Sadly, the civil service and financial resources needed for a plan of such ambition are currently largely deployed elsewhere, grappling with Brexit," said Simmonds. "So despite the warm words, we find it hard to believe there is the capacity to implement the aspirations the government has set out."

Hirigoyen warned that recent government decisions to scale back environmental efforts in some areas must be replaced with decisive action across all government departments. "This speech comes just a couple of weeks after the government watered down proposals for a price cap on minimum energy efficiency standards in domestic properties. If the government truly wants to show 'global leadership' in protecting our environment and tackling climate change, we must see strong actions across the board." ■

Healthy building-focused event comes to London on Valentine's Day

Buildings can be conceived and delivered in new ways that enhance the mental and physical health of occupants. That's the message the Alliance for Sustainable Building Products (ASBP) will be sharing with delegates at the ASBP's Healthy Buildings Conference and Expo 2018 on 14 February.

The ASBP said the event, which will be held at the UCL Roberts Building in London, "once again brings together leaders in the construction and healthcare industries to explore exciting opportunities for a healthier, low carbon built environment".

A statement from the ASBP said the alliance is particularly delighted that air quality expert, Professor Stephen Holgate CBE will be one of the keynote speakers. Professor Holgate is chair of the Royal College of Physicians working party on air pollution and co-author of Every Breath We Take and Better Homes, Better Air, Better Health.

There will also be speakers from a diverse range of organisations including the International WELL Building Institute, the UK Centre for Moisture in Buildings, Glasgow School of Art, HAB Housing, Natural Capital Coalition, British Land, Cullinan Studio and Architype, among others.

Meanwhile, the expo will feature ten leading product manufacturers, research companies and charitable organisations who will be exhibiting throughout the day.

The ASBP said the annual event – sponsored by Wood for Good, Allergy UK and Natureplus – is an "unmissable learning opportunity for construction clients, landlords, designers and anyone with an interest in how buildings impact on human health and wellbeing."

Readers of Passive House Plus magazine can receive a 10% discount on tickets. Visit **asbp.org.uk/healthybuildingsexpo18** and enter promotional code "passivehouseplus" when booking to activate the discount. ■

(above) Delegates at the ASBP's Healthy Buildings Conference and Expo 2017.

NI to get world's first educational 'passive house premium' building

Northern Ireland's South West College has announced that its new Erne Campus in Enniskillen will include the first educational building in the world built to the new passive house premium standard. The campus will be constructed on the site of the former Erne Hospital.

Construction of the 8,200 square metre building is scheduled to begin in March 2018 and will provide employment for over 200 people. Tracey Brothers Ltd. has been appointed as the main contractor for the construction and development of the new Erne Campus. The £24.6m campus will have a capacity for 7,000 pupils annually.

The building, which is due to be completed in January 2020, will further enhance the college's existing global reputation in the sustainable construction sector.

The college's passive house-certified Centre for Renewable Energy and Sustainable Technologies (Crest) in Enniskillen was completed in 2014.

Passive house premium is a new standard developed by the Passive House Institute that certifies passive buildings that also generate a substantial excess of renewable energy.

Beverley Harrison, director of further education at Northern Ireland's Department for the Economy, said: The Department welcomes this significant announcement for South West College and for the Fermanagh area. This new campus demonstrates the Department's continuing commitment to further education and to delivering the skills needed to grow the local economy.

As well as the immediate boost to the local construction sector, the new building will showcase the potential role which further education can play in supporting and developing the local economy and marketing Northern Ireland on a world stage. ■

Going A1-rated & certified passive lifts build costs by 0.1%

The Michael Bennett Group passive house scheme at Madeira Oaks, Enniscorthy, which sold for €170-190,000 each.

The extra cost of building to certified passive house levels – while also scoring an A1 BER – is as low as 0.1%; research at Ulster University has shown.

The additional construction costs for an A1-rated passive house compared with minimum compliance under building regulations are €131, in total, for case study dwellings at Madeira Oaks, Co Wexford. The scheme of twelve houses – featured in detail in issue 15 of Passive House Plus – took on average 13 weeks to build and sold for €170-190,000 each, with a number of the homes purchased by Wexford County Council for social housing. The Michael Bennett Group scheme's low cost and rapid turnaround indicate that pursuing best practice approaches may help rather than hinder the industry in seeking to solve Ireland's housing crisis, while simultaneously exceeding the requirements of the forthcoming nearly zero energy building (nZEB) standard.

According to Dr Shane Colclough, who led the research: "When building houses to tackle the current housing crisis, they can be built right first time, quickly, at no extra cost." Given that passive houses are independently certified, Colclough said the problems with poor quality of construction experienced during the previous building boom could be eliminated for future buildings."

Dr Colclough presented the findings – which are part of a body of work investigating the potential for the passive house standard in Ireland - at a recent academic conference in Florence.

A monitoring report on nine properties in Northern Ireland showed that the passive houses required 38% of the heating costs of the houses built to Northern Ireland's building regulations, whilst simultaneously providing higher indoor air quality and comfort. A report on monitoring of dwellings south of the border is due in early 2018.

The cost analysis of the Wexford homes was carried out by Ulster University in conjunction with Michael Bennett Group's quantity surveyor Seamus Mullins and John Mernagh of Waterford Institute of Technology. By designing the dwelling as a passive house, the design was simplified, the traditional heating system replaced with an integrated heating and domestic hot water unit, and the houses built in 13 weeks, reducing overheads. In addition, all twelve houses in the scheme were certified as complying with the passive house standard at no additional cost.

"The research findings to date indicate that passive houses have been shown to enable developers build low-energy, high-quality nZEB dwellings, three years earlier than required, at no extra cost," said Colclough. "This would have a positive impact on the standard of houses available to purchasers and for social housing, and therefore on Ireland's fossil fuel consumption. It thus has implications for policy at a national level, not just for building standards, but also for training among industry professionals, to ensure they can build nZEB dwellings to which Ireland is committed under EU directives." ■

Chair of post-Grenfell fire review "shocked" by construction culture

Words by Kate de Selincourt

The engineer tasked by the UK Government with examining building fire safety regulation in England following the Grenfell fire has said she is shocked by construction practices. The industry urgently needs to change its culture, and "clearly identifiable" individuals must take responsibility for what is built, she concludes.

In a damning report on the integrity of the regulatory system and the competence of the construction industry, Dame Judith Hackitt writes: "I have been shocked by some of the practices I have heard about... it is not difficult to see how those who are inclined to take shortcuts can do so." She adds: "There is confusion about roles and responsibilities throughout and a general lack of competence and accreditation."

The interim report of the Independent Review of Building Regulations and Fire Safety, published by the communities department just before Christmas, makes it clear that root and branch reform will be needed. "We have identified numerous ways in which the system is gamed or worked around ...the regulatory system is not fit for purpose... and quality assurance of materials and people is seriously lacking."

"The mindset of doing things as cheaply as possible and passing on responsibility for problems and shortcomings to others must stop," she writes. The report was summed up by the website Construction Index: "In essence, contractors are out of control."

Dame Judith's report condemned the common assumption that if a design had passed building control this meant it was safe, and expressed dismay that what is designed is not necessarily what is being built.

In future, she said, "primary responsibility for ensuring that buildings are fit for purpose must rest with those who commission, design and build the project. Accountability must rest with clearly identifiable senior individuals and not be dispersed through the supply chain."

"There needs to be a golden thread for all complex and high-risk building projects, so that the original design intent is preserved and recorded, and any changes go through a formal review process involving people who are competent and who understand the key features of the design."

The building control system is inadequate, the review says, owing to competition, lack of power on the side of private inspectors, and lack of qualifications in local authority teams. The report called for demonstrable independence of inspection, and stronger enforcement of regulations with meaningful penalties.

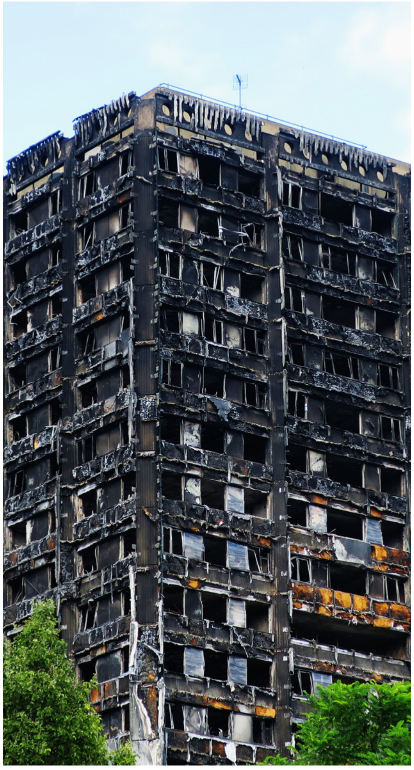

Photo: Alex Donohue

The report concludes: "We have heard that [competition] leads to situations where BCB personnel can fail to 'win business' where they will not commit in advance to approval of more risky designs, and that those who do win business can become far too embedded in supporting the building design process".

The report was also concerned that there is no requirement to inform building control of potentially significant changes to building work and indeed building "appears frequently to commence well before the plans are approved," while approved plans "frequently are not followed as a result of business processes such as value engineering." Specific recommendations are expected in the next stage of the review. "Phase two will focus on defining a revised regulatory system which will be simpler, clearer to all involved and deliver better overall outcomes," the report reads.

Critics say review doesn't go far enough

While the interim findings have been welcomed, some industry bodies, commentators and MPs have pointed to omissions, including the failure to mandate sprinklers in all tall buildings, failure to end the use of desktop assessments altogether, and failure to ban the use of combustible materials in tall buildings — even though, as the report itself notes, very many of the submissions to the inquiry recommended these measures as a matter of urgency.

The RIBA issued a statement expressing disappointment at the lack of an immediate prohibition on the use of combustible materials in the external construction of high-rise buildings, something they had called for in evidence. Doubts have also been expressed about whether there is the level of competence in construction to take on the roles the review is calling for.

The All-Party Parliamentary Fire Safety and Rescue Group (APPG) has written to the government calling for "urgent changes" to the regulations, including abolition of the use of desktop studies.

But while not calling for an all-out ban, theHackitt review does recommend that the government should "significantly restrict" their use "to ensure they are only used where appropriate and with sufficient, relevant test evidence," adding "those undertaking desktop studies must be able to demonstrate suitable competence. "The review also called for "immediate action" to make the building regulations and Approved Document B clear and consistent.

Communities Secretary Sajid Javid welcomed the interim report and told parliament the government will commission work to produce a new British standard on when and how desktop assessments can be used, and "will work quickly with industry experts to complete work on clarifying the guidance and approved documents on fire safety."

While construction industry practices are strongly condemned by the interim report, there is little criticism of successive governments for having ignored warnings over many years about the building regulations and approved guidance.

Manufacturers' marketing practices promoting the use of combustible materials in tall buildings are also not examined, though the review team does intend to press for more transparency: "During phase two, the case must be examined for ... product testing data to be made transparent and publicly available and for a much clearer system of product classification." ■

Disastrous Preston retrofit scheme remains unresolved

Words by Kate de Selincourt

(above) Poor workmanship at the Preston scheme including (l-r) poor detailing at the roof line, discontinuous drainage installations; and uneven installation of the insulation system.

A disastrous failed external insulation contract run under a government energy saving scheme has affected up to 390 homes in Preston with water penetration, mould and damp. Four years on the problems, some of them severe, have only been rectified for some of the affected households. Occupants, many elderly and on low incomes, have in some cases reportedly been forced to pay for repairs themselves.

The installations in Preston took place under the Community Energy Saving Programme (CESP), which required energy companies to fund energy saving measures in disadvantaged communities. And although changes were made to subsequent government schemes, figures from Ofgem suggest that some installations carried out under the newer Energy Company Obligation (ECO) programme are continuing to fail.

In Preston, the homes affected are small terraced houses built around 1900 in the Fishwick area of the city. These properties had external wall insulation fitted, along with other measures, in the 'mitigation period' at the end of CESP in early 2013.

Photographs shared with Passive House Plus by Preston City Council show how bad the damage has been to some properties, with drastic deterioration to the interior surfaces, black mould, and florid fungal growths. There have also been reports of worsening respiratory disorders and hospitalisation of some tenants.

According to a Preston City Council report in 2015, in some cases plaster, furniture and belongings were damaged. There were even reports of water exiting from electrical sockets, and of collapsed ceilings.

Site visit reports by the insulation supplier, Wetherby, describe water coming through walls at the window head and behind drain hoppers that were failing to carry rainwater away.

Sources contacted by Passive House Plus, including Ofgem, agree that poor workmanship was a major reason for the failures. Photographs of the work show insulation cappings that tilt backwards towards the wall; discontinuous gutters, hoppers and downpipes; and broken cement fillets that could allow rainwater to soak into the wall.

Many of the houses apparently also had narrow "rat trap" cavities that were previously filled with insulation, which went unnoticed when the external insulation was applied. The water penetration following the external wall insulation [EWI] installation reportedly caused much of this insulation to become saturated, acting as a reservoir for moisture in the walls.

As John Proctor of power generation firm Intergen, the original funder of the work, explained: "My understanding is the EWI system led to dampness coming into the houses. There was nothing wrong with the system per se but the installers didn't do a good job tying in the existing guttering, so water was backing up and going into the walls. And some of the houses had cavity insulation, which has become saturated."

The installation under the original contract was carried out by a firm, which has since gone into liquidation. The installer was apparently under considerable time pressure.

Intergen was paying for the work as part of its obligation under CESP, but in Ofgem's words, "delivery was at risk". By 2012, at the end of the allotted three years, Intergen had only delivered 6.4% of its obligation.
In January 2013, Ofgem notified energy companies that were late with their obligations —including Intergen — of a new deadline to complete works: 30 April 2013.

As Preston City Council energy officer Andrea Howe, recalls: "We have a lot of eligible households, so a lot of energy companies came to Preston. [They] were desperate to get rid of the funds to avoid fines."

It appears that Intergen was racing to make up three years' shortfall in just a few months, and this pressure was passed on to the contractors.

This is corroborated by Bob Deane, managing director of EWI supplier Wetherby, who told Passive House Plus the contractor was working to a very tight deadline because of the "frantic last minute dash to try to claim the carbon". Bob Deane says that Wetherby, who periodically inspect installations of their EWI system, warned on numerous occasions that the detailing of the EWI in Fishwick was unsatisfactory and would fail, "but nobody would take our advice or accept our detailing. It was an absolute nightmare from start to finish."

He continues: "The installers said they wouldn't get paid till it was all done. They wouldn't extend the roofs out over the insulation because they said they were not being paid to do so." Bob Deane adds that after the installer went into liquidation, Wetherby themselves were not paid for the materials they had supplied.

Problems, primarily with water ingress, were first reported to Preston City Council

(above) Evidence of water ingress and severe fungal growth inside the properties.

at the end of 2013, and gathered pace the following year. However despite the obvious poor quality of the work and the magnitude of the problems, Preston Council told Passive House Plus it was extremely hard to get anyone to take responsibility for putting it right.

According to Andrea Howe: "As soon as the complaints started to come in, everyone who had been involved turned their backs on the residents, even though it was still in the defects liability period.

"On a weekly basis I was contacting everyone who had ever been involved or those in the industry who I thought could help, and got nowhere," she said. Bodies the council approached for help included the contractors, the managing agent, the energy company who funded the work, and the regulator Ofgem.

Ofgem did finally pursue redress with Intergen, but according to Andrea Howe, only a minority of affected homes were included, and some of the worst affected were left out. "We did our best to collect the names and addresses of people affected, but after a point Ofgem said 'we can't deal with any more now' when we had only got 62 addresses. They just cut us off."

Ofgem told Passive House plus: "Intergen was subject to enforcement action by Ofgem for failing to carry out its obligations under CESP [the firm only managed just over half in total], and in concluding that enforcement case, Intergen agreed to remediate the 62 properties who had reported issues at that point in time." Approximately £1.5million is believed to have been allocated to fix these 62 homes.

Passive House Plus has attempted to find out directly from the other original actors what went wrong and why, what had been done to rectify matters, and why so many people have been left with such terrible problems for so long, but this has proved difficult. Apart from some of those quoted above, most of the people involved have moved on to different companies, and there seem to be few records available.

After the original contractor went into liquidation, another firm with the same director also went into liquidation, and this team could not be traced. John Proctor at Intergen, who is overseeing the funding of the current remediation, was not involved in the original project, and was "unable to provide [any] information" on the contractual history of the project.

Preston Council and Intergen both told Passive House Plus that Anesco, a large energy services firm, was involved in a brokerage or managing agent capacity. However it appears that the people involved have all left, and current staff at Anesco told Passive House Plus they were unable to find any record of the work, the size of the contract, the brokerage fee they charged, or any steps taken to secure remediation.

As one of the people Passive House Plus spoke to put it, many people originally involved in the project have disappeared "like snow off a dyke".

The problems, however, have not disappeared. "The complaints haven't stopped," Andrea Howe says. "Residents are angry." Vulnerable householders have had to pay to rectify urgent problems themselves – for example, where boiler flues had been blocked, or pipes had been dislodged during installation, leading to sewage collecting behind the cladding.

And the issues are by no means yet resolved for many properties. E.On, who were appointed to carry out the remediation of the first 62 properties, began work in mid-2017. Intergen told Passive House Plus that the insulation has been stripped off, saturated cavity insulation removed, rainwater goods repaired and the insulation reinstated.

Regarding the others, Ofgem says: "We have been working with interested stakeholders to achieve the best possible resolution in respect of any other properties which may have been affected. These efforts are ongoing." According to Andrea Howe, some money for further remediation has been identified by the charity National Energy Action. However, the amount is thought to be less than has been spent on remediating the first 60 houses, although many more than 60 dwellings are believed still to require work. Just as Passive House Plus went to press Preston City Council were contacted by some affected residents complaining that, once again, they had been turned down for help.

The story of the Preston homes was brought as evidence for consideration by the team from the Bonfield Review of the energy retrofit industry, alongside representatives from the then Department of Energy and Climate Change. According to a note in the review's 'Each Home Counts' report: "E.On... will be in close dialogue throughout the Review's implementation to ensure that further work makes use of the best available practices, as they are defined."

Progress remains painfully slow for the residents of Fishwick. "EWI was meant to increase the value of property: this is not the case here," Andrea Howe says. "Many residents are struggling to sell, or to re-let when tenants move out. Many are in worse fuel poverty than they were before the scheme." This is not how "community energy saving" was meant to work. ■

(above) Poorly installed external insulation with capping (top photo) that will almost certainly drain rainwater back into the wall behind.

Are government backed installations still failing?

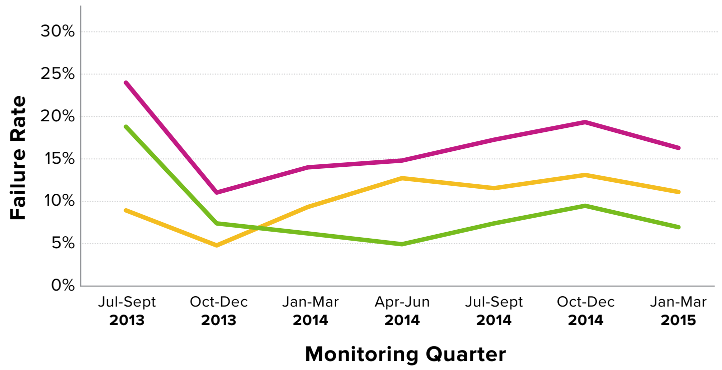

FIGURE 4.3: TECHNICAL MONITORING FAILURE RATE OVER TIME

Ofgem Energy Companies Obligation technical monitoring report, December 2015

Many people, and many in low income and vulnerable households, have benefitted greatly from energy efficiency improvements under energy company obligations. Yet disasters such as the one in Preston have had the opposite effect, making people's lives immeasurably worse. Unfortunately, installation failures appear to be continuing under ECO (Energy Company Obligation), the replacement scheme.

During the first two years of ECO, installations failed technical monitoring 5%-12% of the time – averaging around 10% (see graph – red line).

Around 1.63 million measures were installed in the first two years of ECO. If the monitored properties were representative, about 10% – perhaps 160,000 energy saving measures – were faulty in some way.

Where a faulty installation is reported to Ofgem it has to be remediated for the carbon to be claimed. However, this only applies to the monitored sample – only around 7% of the total. That would leave the remaining 93% of 160,000 faulty installations – around 150,000 – unreported and unfixed.

Ofgem is at pains to point out that other monitoring and redress mechanisms are in place alongside their own, including energy companies' own systems, and also customer complaints to guarantee companies – though they offered no figures.

While the technical failure rate has improved, it is still running between 3 and 8% for some measures, including, worryingly, cavity wall insulation, where 3.5% of installations are failing the question "does the current condition of the property suggest that it was suitable for the material that has been installed?"

With an estimated 700,000 CWI installations under ECO , that is a very large number (perhaps 20,000) potentially unsuitable installations. And despite the presence of a guarantee scheme under CIGA (the Cavity Insulation Guarantee Agency) householders are reportedly not always getting the problems put right, leaving them in a similar situation to the residents in Preston.

Many people believe the danger of installation disasters is inherent in the very structure of the energy company obligations, with the pressure to carry out installations for the lowest possible cost, hard deadlines and unpredictable programme changes from year to year.

When CERT and CESP were closed in 2013, the government's evaluation found that "pressure to keep prices low and deliver high volumes in short timescales were ... significant factors in promoting poor quality work." However ECO (and the now-defunct Green Deal) were designed before these evaluations were complete, so perhaps it is not surprising that similar flaws were built in.

This approach takes little heed of the realities of the construction industry, and may be encouraging inexperienced players to crowd the market. As Wetherby Building System's Bob Dean puts it: "We have been working hard to get the quality up, adhering to PAS 2030 (a new qualification that came in with ECO), but the government seem to think they can just turn us on and off.

"There is no constant stream of work. There's still some running but there is a huge contrast to a situation like you had in 2012 when every man and his dog was suddenly an approved installer."

The measure-based (rather than house-centred) approach has also been repeatedly criticised. Even in the latest ECO technical monitoring, there is nothing to flag the way measures might interact – for example, that new glazing might clash with a substandard ventilation system leaving a property underventilated. Although PAS 2030 is meant to address this, the standard is not always followed or effectively enforced.

The government has been repeatedly warned about these issues, and in 2015, it set up the Bonfield Review to propose a way forward. The review report, Each Home Counts (EHC) was released in December 2016.

EHC implementation board member Liz Male says the issue of someone taking design responsibility, with an overview of the whole building "has been a crucial issue throughout the Each Home Counts process."

Male is involved with developing a "quality mark" which, she explains, would be backed by insurance, and give a clear, single pathway for customer complaint and redress. She told Passive House Plus the board believed that major retrofit backers and funders, including the government and private finance bodies looking to invest in energy efficiency, were going to require the quality mark for anyone carrying out work they fund.

Prior to Grenfell some suspected that this initiative would disappear into the long grass. However, says Male, after the Grenfell disaster, there is an unprecedented opportunity – and a massive responsibility – to push through improvements. "We have to keep going," she said. ■

1948:
The Dover Sun House

In his second column on visionary eco-buildings of the 20th century, Dr Marc Ó Riain looks at the Dover Sun House, which used a pioneering salt solution to capture and store solar energy.

There are two paradigms in low energy building. The first is based on energy replacement technologies and the second is based on energy conservation. In the coming set of articles, we will explore seminal mid-century exemplars that would give rise to passive house principles. This article tracks the work of two pioneering women who smashed the glass ceilings of architecture and engineering to produce one of the first active solar buildings.

Human application of technologies during World War Two shifted societal perception to a position that we believed our destiny was in our own hands and any social issue could be resolved by the proper application of technology. The world faced a shortage of oil and coal after 1945 and up to the discovery of Middle Eastern oil reserves (Ilkes 1944).

> As the interior temperature dropped the salt would recrystallize, releasing the absorbed heat radiantly through the surface of the drums.

Much like many subsequent energy crisis periods, this led to research into alternative energy such as solar housing, geothermal heating, wind energy, and shale oil extraction in the US.

In the late '30s and early '40s, MIT's solar energy conversion research used a variety of solutions to prototype solar panels for space heating, using glass panels with black painted metal panels and brine solutions to capture solar heat gain and store it. In the late 1940s an MIT chemical engineer, Maria Telkes developed a new-phase change strategy to store heat for up to 10 days, using a 'Glauber salt' solution (Natrium Sulfuricium).

Supported by funding from Boston heiress Amelia Peabody, she teamed up with the architect Eleanor Raymond to develop a practical experimental house as a test-bed for the technology in Dover, Massachusetts. The "sun wall chemical heat storage" used double glazing separated from a black metal sheet by an air cavity on the south face of the building. Black convection pipes in the cavity absorbed heat which was then blown into heat bins. The 'Glauber salt' solution, which was stored alongside the habitable rooms, liquefied and stored the heat at 32C in a phase change process. As the interior temperature dropped the salt would recrystallize, releasing the absorbed heat radiantly through the surface of the drums. Thermostatically controlled fans then circulated the warm air into the rooms.

Concerned with the importance of view and passive heat gain the architect raised the vertical solar collectors to allow for windows at ground level. The design resulted in a long wedge shaped building oriented to the south, with circulation to the north side and habitable rooms to the south. Although the long narrow building design optimised the area for solar collectors, it also significantly increased construction costs.

The design's weakness was that it attempted to use the new solar technology to meet 100% of the space heat demand without the need for an auxiliary heating system. Initially this realised 91% of the space heat demand in 1948-49, but the performance fell away in the following years due to systemic problems.

The modular double glazed panes became a key design problem, as the sealant dried out in the extreme temperatures behind the glass. This quickly resulted in air and weather infiltration, compromising the solar heating system performance. The 28 tonnes of 'Glauber salt' stratified in the bins and had to be replaced annually. The salt also caused the chemical bins to rust and leak. The system failed to heat the house adequately and the occupants frequently complained about the cold in the winter.

The architect tracked the energy costs of Dover Sun House and the neighbouring Border House. She found that the electrical costs of driving the circulation fans vastly outweighed any potential oil heating savings. In 1954 the solar heating system was removed and replaced with a conventional oil burning furnace.

Whilst the experiment may have resulted in a failure it underlined the potential of active solar systems to deliver supplementary space heating for houses (Barber 2016). Maria Telkes became the first recipient of the Society of Women Engineers achievement award in 1952 and Eleanor Raymond became a fellow of the American Institute of Architects in 1961.

In the '30s and early '40s, other modernist designers like the Chicago-based Keck brothers were pioneering the use of doubling glazing and passive heat gain to practically reduce building energy costs by 15-20%. We will explore their work in the next article. ■

(above and inset) The Dover Sun House on the cover of the March 1949 issue of Popular Science; MIT chemical engineer Maria Telkes, whose work on using phase change materials as energy stores was central to the project.

Dr Marc Ó Riain is the president emeritus of the Institute of Designers in Ireland, a founding editor of Iterations design research journal and practice review, a former director of Irish Design 2015, a board member of the new Design Enterprise Skillsnet and has completed a PhD in low energy building retrofit, realising Ireland's first commercial NZEB retrofit in 2013.

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The digital magazine is available to subscribers on www.passive.ie

£125 per year

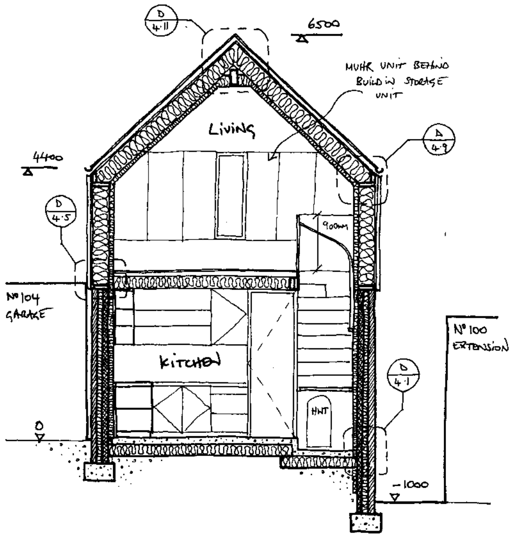
Space heating bill (PHPP estimate)

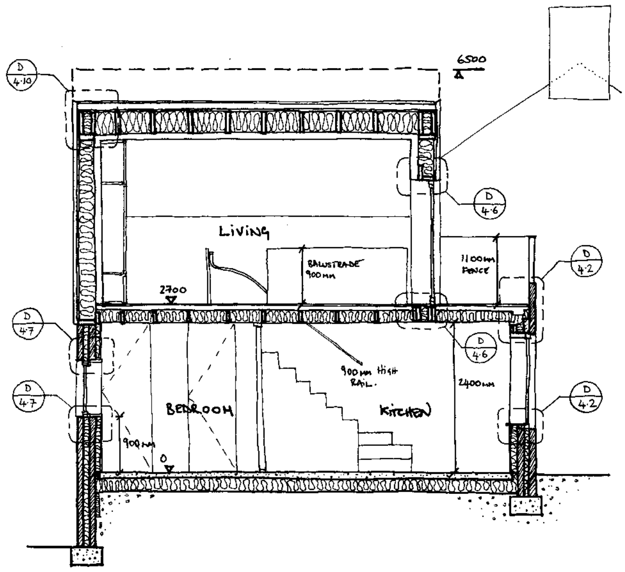
Building type: Derelict shop converted into 45 sqm home

Location: Shrewsbury, England

Budget: £37,000

Standard: Enerphit (indicative)





FROM DERELICT SHOP TO

TINY LOW ENERGY HOME

In 2014, one couple decided to give up life in a van and convert an old newsagents in Shrewsbury into a very small low energy home, using the principles of the passive house standard as their guide. So how did it work out, and what is life really like in such a small home?

Words by David W Smith

Photography: Dan Farrar

When architect Clare Williamson and her structural engineer husband Oscar Baldry moved into their tiny low energy house in Shrewsbury back in 2015, it seemed large compared to what they had been used to.

The pair had just spent 18 months living in a panelled builder's van in the UK — nine months exploring the whole country, and the rest of the time parked outside the derelict newsagent's they had bought to retrofit in the Shropshire medieval town. After such confinement, the 42 square metres of 'Beehive', as they dubbed it, represented untold luxury.

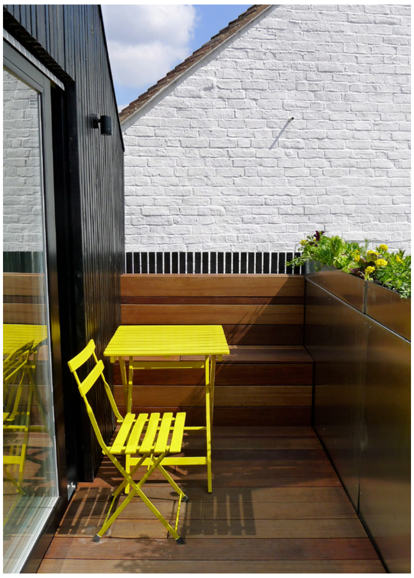
It is true the decision to purchase such a small property came partly out of necessity. They wanted to get on the housing ladder and could afford little more. However, it also accorded with their personal values.

They had watched many videos about the tiny house movement, which had begun in the US as a reaction to rising house prices and the ever-expanding size of American houses. The concept was starting to take off in the UK too, with developments such as Abito's 32.8 square metre 'intelligent living spaces', in Manchester.

"We loved tiny house as it fitted in with where we were coming from," Clare says. "Not only had we spent a lot of time living in a van in the UK, and also New Zealand, we'd also just come back from backpacking around the world and living in a tent. In the developing world, we'd seen how people make do with very little.

We often slept in tents, and later lived in another van for nearly a year in New Zealand. Having spent so much time in a confined area, we realised we didn't need a lot of space or material items. After we moved into the Beehive, it seemed very large!"

> The tiny house movement… had begun in the US as a reaction to rising house prices and the ever-expanding size of American houses.



The journey to their new life in Shrewsbury began in 2011 when Clare and Oscar quit their jobs in London and set off on their travels. After returning home in 2013, they decided they did not want to return to London, and set off to explore their home country. At first, they considered a new life in Wales, but Oscar then found a part-time job in Shrewsbury, and they fell in love with the quaint old town.

They found the derelict newsagent's on sale for £50,000, but it had been refused planning permission twice due to proposed overdevelopment. They offered £33,500 subject to planning permission, and the owner snapped their hands off. After getting the keys in February 2014, they set to work with Clare as full-time project manager, living out of the van parked in the front yard.

The decision to retrofit the Beehive using the principles of passive house design was taken near the outset. Clare had attended a training programme in sustainable building skills in Germany in 2013, and decided to pursue full passive house consultant training in 2014. The Beehive project developed into a test bed for passive house principles.

"We both wanted to be sure we understood the rigours of the passive house standard and to see if the end result was something we liked living in, before suggesting it to clients. The experience armed us with lots of useful nuggets and convinced us it was worth it. Above all, we love having a cosy house that is full of light and fresh air," she says.

The Beehive was a true self-build, with the couple carrying out 90% of the work. Clare made sure all building materials were ready on Thursday evening when Oscar returned from work and they spent three-day weekends, and evenings, working on the house.

When they finally completed it in May 2015, they were able to move into a comfortable one-bedroom property where everything has its place. The entrance leads into the kitchen, and the bedroom is at the back on the ground floor. Upstairs, there is a dual living and working space that opens on to a little terrace at the front.

The couple specified internal insulation to the existing walls on the ground floor, although it was not their preferred method. Clare says they had no option on the ground floor because on three sides of the building, the external walls formed the boundary of ownership. "We had to sacrifice quite a lot of space to create the insulation and make a very warm house, but I'm glad we did," she says.

Insulating walls internally generally carries more risk of mould, because it can create a 'dew point' where water vapour condenses on the cold surface of the original wall, behind the new insulation, where there is a sudden drop in temperature. Unfortunately, with their strict budget, the couple could not carry out dynamic condensation calculations as part of the design. Shrewsbury is in a moderate risk area in terms of exposure to wind-driven rain, according to the BRE, which may help matters.

Instead, the couple's approach was based on their best judgment at the time. Clare carried out basic calculations that informed the decision to split the internal PIR insulation into two layers, sandwiching a vapour control layer between the insulation boards.

This, together with the heat recovery ventilation system, the bead insulation installed in the original wall cavity (which keeps the inner wall warm), the repointing of joints, and the sheltered nature of the site, all help to mitigate the risk of interstitial condensation. The couple also added a second vapour control layer in the shower room.

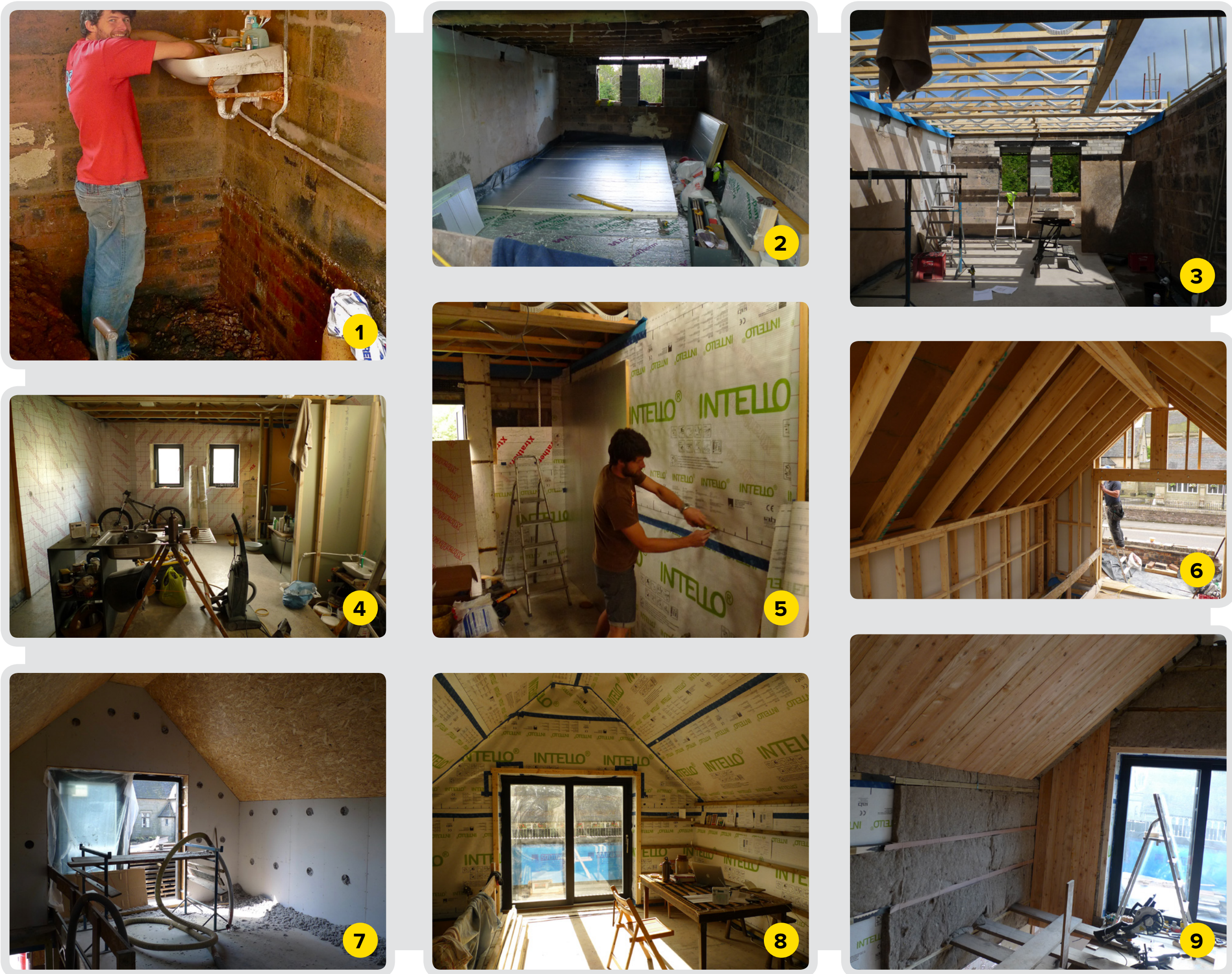
By contrast, the new timber frame first-floor walls and roof are of a fully breathable construction consisting of a twin-stud wall filled with Warmcel cellulose (recycled newspaper) insulation. The building scored an impressive airtightness test result of 0.5 air changes per hour at 50 Pascals – a score that not only blitzes the requirement for Enerphit (the passive house standard for retrofit), but comfortably beats the new build passive house target of 0.6 ACH too.

Just two 400W radiators now heat the house and a 55W towel rail paid for through a renewable tariff. Monitoring shows fairly constant 45% humidity inside (between 40% and 60% is considered healthy) and the temperature at around 21C.

Clare says the house has served its purpose as a testing ground, and she cannot speak highly enough of passive house to clients who approach the couple's practice, CandO Design. "Having grown up in a large draughty Northern Irish house where heating was used sparingly, I love living in comfort without feeling it's costing the earth. I must say that my idea of comfort is changing though. I used to be hardier, but I'm gradually turning into a big softy."

▶

CONSTRUCTION IN PROGRESS



1 Oscar Baldry getting down to work in the old newsagent's shop; 2 laying Kingspan and Ecotherm insulation in the ground floor of the old shop; 3 first floor metal web joist detailing, with membrane behind the joists for airtightness; 4 ground floor walls feature 50mm Xtratherm internal insulation; 5 this is followed inside by an Intello vapour control barrier and a further 25mm Xtratherm; 6 the new timber frame first-floor twin-stud walls and roof rafters are of a fully breathable construction and full-filled with Warmcel cellulose insulation; 7 holes in the timber-frame where the Warmcel insulation was pumped in; 8 a pro clima Intello membrane on the inside of the first-floor walls and roof; 9 and finally, 50mm Thermafleece (sheep wool) lined service cavity to the interior.

Living in a tiny house: **is it for everyone?**

By Clare Williamson, Beehive architect & homeowner

Living in tents, vans and then the Beehive has worked extremely well for my husband and I as each have been appropriate to our needs at the time.

But I think true tiny houses, smaller than ours, are only healthy where one's lifestyle involves spending a lot of time outdoors or elsewhere, as we did when we lived in the van.

Of course, everyone has different relationships and so called 'needs' so I think being able to do this is a very personal thing related to one's values. The addition of good design and comfort is also critical to small living.

We like how living in small spaces has constrained us from acquiring unnecessary material possessions or simply stuff that isn't used. Other people might hate this.

The Beehive is larger in scale than a true tiny house and is completely adequate for us to live a very comfortable healthy lifestyle and have friends around for a meal. This is partly to do with the high level of space efficiency and storage.

The main limitation we have found is we would like a spare room rather than sofa bed so family feel they can stay longer. But I don't think this is insurmountable if a group of small houses had a shared rentable house nearby.

EXACTLY HOW MUCH ENERGY DOES THE BEEHIVE USE?

Although the Beehive did not quite meet the Enerphit (passive house retrofit) standard based on calculations done by Clare when the building was completed, there is reason to believe that it would fare better if re-assessed.

Following the efforts of passive house consultants Nick Grant and Alan Clarke to prove that PHPP, the passive house design software, may have previously underestimated the benefits from internal heat gains in smaller buildings, the latest version of PHPP has been updated to address the issue.

And in this case it seems to have delivered: a broad brushstroke analysis kindly provided by Nick Grant for this article shows that when re-calculated using the new PHPP, the Beehive's space heating demand dropped to 20 kWh/m²/yr, comfortably inside the Enerphit target of 25, while the building appears to have avoided exceeding the overheating target (not to exceed 25C internally more than 10% of the time) by the skin of its teeth.

But in spite of this, it appears to fall short of one key target: the calculated primary energy total of circa 220 kWh/m²/yr is well over the passive house target of 120. And the house's monitored energy performance appears to match the calculated figures, working out at 226 kWh/m²/yr worth of primary energy. This assumes the same primary energy factor used in PHPP: each kilowatt of electricity used in the building represents 2.7 kilowatts of primary energy, principally due to inefficient power generation. But this apparent correlation does not tell the full story.

There is one glaringly obvious reason why the Beehive might have such high primary energy demand: the hot water is heated solely by an electric immersion, and with thermostatic control, meaning the tank is constantly kept hot in spite of Clare and Oscar's apparently parsimonious hot water use.

There is also the effect of the building's small size, which is penalised in PHPP. As Nick Grant points out, if the home's treated floor area clocked a more typical 120 sqm rather than 40 sqm, much of the energy load – the likes of computers, kitchen appliances and bathing – would be divided by three times the area.

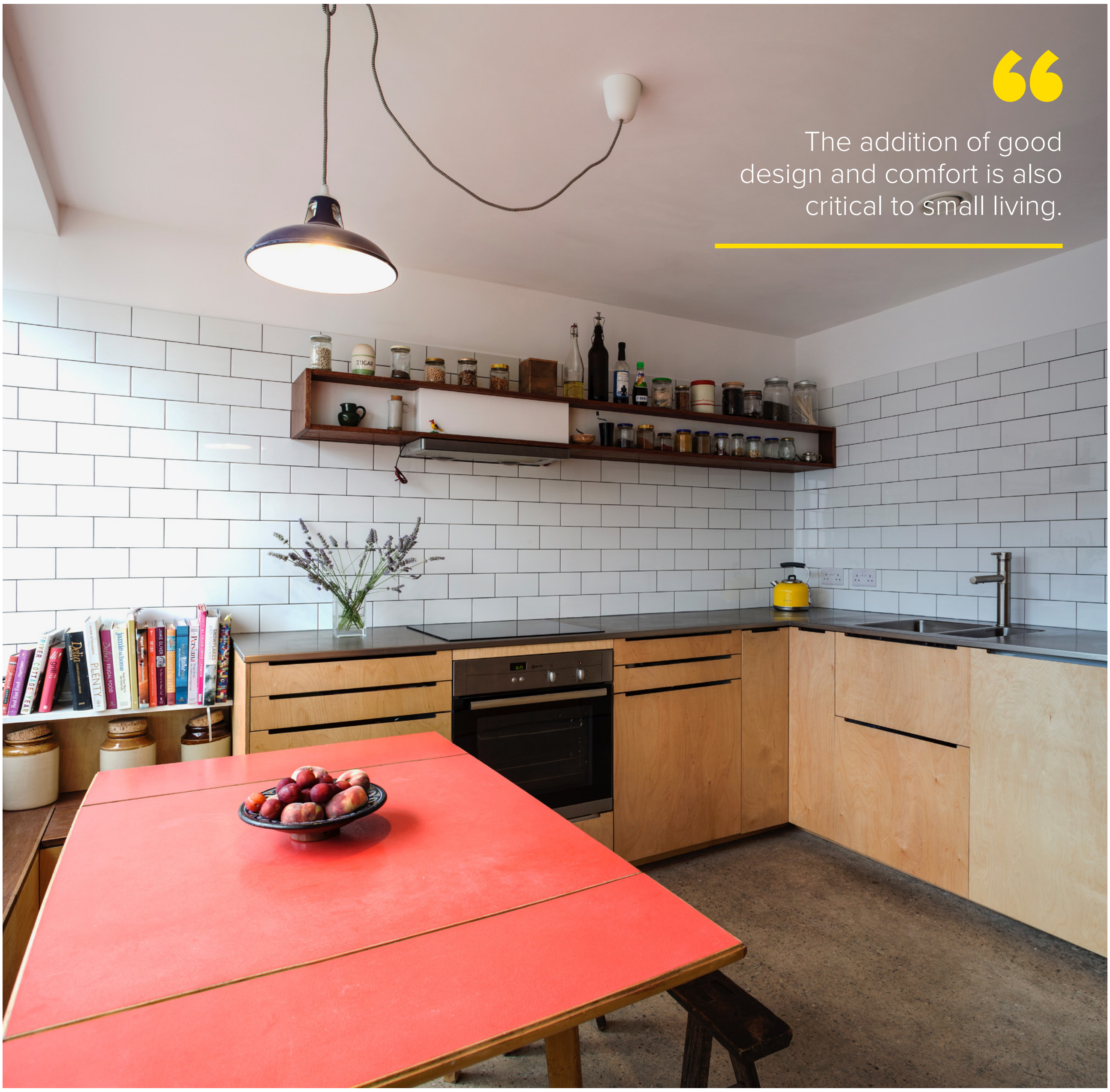
The monitored energy use figures work out at 3,519 kWh per annum at the electricity meter, or £521 (excluding standing charges and levies) based on the comparatively high unit price of £0.15p that Clare and Oscar pay for guaranteed renewable electricity supply. But as Clare explains, there are a number of factors which may be conspiring to inflate those figures.

Firstly, Clare works from home, meaning attendant additional energy use. "A laptop, screen and printer are working most of the time," says Clare. "We Airbnb the property intermittently (at one stage we had a couple stay there for 2 months) so we have no idea of their usage, and I have been doing more washing than normal due to doing holiday lets on this and another property."

Though the couple bought second-hand appliances with "decent ratings", Clare suspects a faulty small freezing compartment in the fridge may be an energy culprit, with guests often not closing it properly.

Arguably, there may be little point in comparing predicted versus measured total energy use in an individual home in this kind of detail, because the two figures are unlikely to be making the same assumptions about usage. Space heating in a passive house may be something of an exception in this regard, in that the scope for usage fluctuation is reduced by all but eliminating the need for space heating. But people don't tend to lead identikit lives, so often wildly divergent behaviours mean that to draw accurate conclusions about typical total energy use (i.e. including electrical and hot water consumption as well), data from large numbers of buildings may be required.

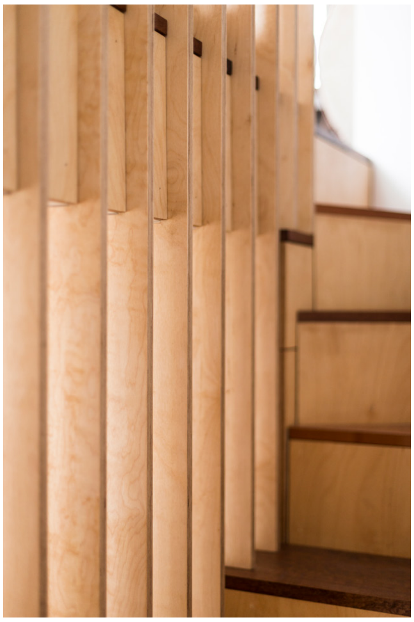
With regards to primary energy, in real terms Clare and Oscar's decision to go with a renewable electricity supplier may mean the actual primary energy use is substantially lower than the grid average. Given that this is a personal choice that could be overturned by simply switching supplier, it is sensible that this is not part of the consideration in determining a building's energy or carbon impacts.

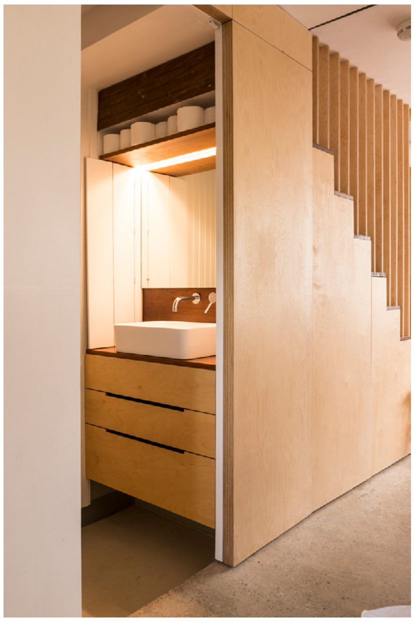


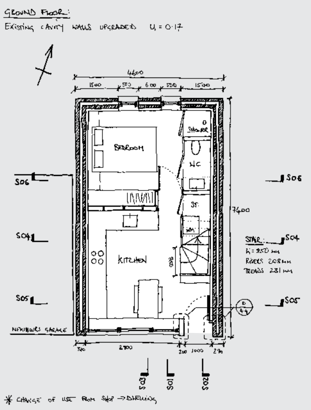
> The addition of good design and comfort is also critical to small living.

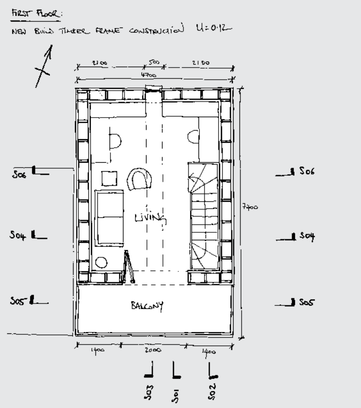
SELECTED PROJECT DETAILS

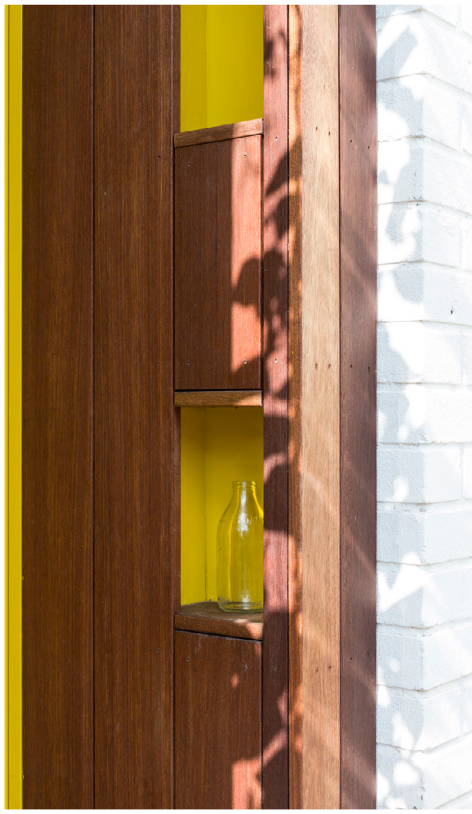
Clients: Clare Williamson & Oscar Baldry
Architect & furniture: CandO Design
Structural engineering: Bob Johnson Structural Engineers (Oscar Baldry)
Airtightness test: Encraft
Cellulose insulation: Warmcel/PYC Systems
Airtightness products: Ecological Building Systems, via PYC Systems
Floor insulation: Kingspan & Ecotherm, via Seconds & Co
Internal insulation: Xtratherm
Cavity insulation: Instabead
Windows: Rationel, via European Window Systems
Bespoke window: Manleys Joinery
Passive door: James Latham Ltd
Ventilation: FIS Heat Recovery Ventilation











IN DETAIL

Building type:
Conversion & extension of derelict 1960 newsagents into two-storey, 45 sqm house

Location:
Longden Road, Shrewsbury, Shropshire

Budget: £37,000 (incl all build costs but not planning, legal fees and affordable housing contribution). The site cost an additional £33,500.

Space heating demand (indicative PHPP calcs): 20 kWh/m²/yr

Heat load (indicative PHPP calcs): 14 W/m²

Primary energy demand (indicative PHPP calcs): 220 kWh/m²/yr

Overheating frequency (indicative PHPP calcs): 10% of year above 25C

Form factor (surface area of thermal envelope / treated floor area): 4.5

Energy performance certificate (EPC):
C 73 (due to electric heating/hot water)

Measured energy consumption: 82.5 kWh/m²/yr (based on bills Jan to July 2015)

Energy bills: £800/yr on electricity including all heating, hot water and cooking (based on bills Jan to July 2015). £125 per year for space heating (PHPP estimate).

Airtightness (at 50 Pascals):
0.5 air changes per hour

GROUND FLOOR
Before: Approximately 70mm concrete.
After: 150mm blinded hardcore; DPM; 200mm Kingspan/Ecotherm insulation; second DPM to contain slab; 100mm reinforced concrete to finish – ground down to expose aggregate – with 75mm perimeter PIR insulation to upstands.
U-value: 0.11 W/m²K

GROUND FLOOR WALLS
Before: Brick-block cavity walls with empty 70mm cavity. U-value: 1 W/m²K
After: 70mm Platinum EPS bead insulation to cavity, followed inside by 50mm Xtratherm internal insulation, vapour barrier, 25mm Xtratherm insulation. U-value: 0.16 W/m²K

First floor extension walls: 270mm twin-stud timber frame walls full-filled with Warmcel. Fermacell with pro clima Solitex Fronta Quattro membrane fully taped and sealed as wind-tightness membrane to the exterior. Plasterboard, pro clima Intello airtightness membrane and 50mm Thermafleece (sheep wool) lined service cavity to the interior.
U-value: 0.12 W/m²K.

New roof: Clay tiles externally on 50x35 battens and counter-battens, followed inside by pro clima Solitex membrane, 25mm wood fibre on 290mm rafters full-filled with Warmcel insulation, 11mm OSB, pro clima Intello membrane and 50mm Thermafleece-lined service cavity to the interior.
U-value: 0.10 W/m²K

WINDOWS & DOORS
Before:
Single glazed, timber windows and doors.
Overall approximate U-value: 3.50 W/m²K

New triple glazed windows: Rational Aura Plus timber aluminium triple glazed, argon-filled windows. Average U-value of 1.05 W/m²K.

Bespoke timber window: Triple glazed, argon-filled window from Manleys Joinery, with warm edge spacer.
U-value: 0.80 W/m²K

Entrance door: Passive House Institute certified Moralt FERRO Passiv timber door, with insulated core and 10 year guarantee against bowing.
U-value: 0.80 W/m²K

Heating: 2 x 400W Adax electric heaters and 55W electric towel heater to bathroom

Ventilation: Titon HRV1.25 heat recovery ventilation system, non certified heat recovery efficiency of 91%

Green materials: Warmcel and sheep's wool insulation used where suitable, Osmo oil finish to all wood floors/birch ply walls/kitchen, bed from the 'freecycle' network, with all free standing furniture being hand-me-downs from family or Gumtree with the exception of a yellow metal chair.

■

ESSEX VILLAGE BECOMES **ECO-PIONEER**

WITH LATEST PASSIVE HOUSE SCHEME

Hastoe Housing, a trailblazer in the development of affordable passive housing, have completed their second scheme in the Essex village of Wimbish — 11 houses whose simple and traditional building methods and materials mask cutting-edge energy efficiency.

Words by David W Smith

£35-65
estimated annual heating costs

Building type:
11 cavity wall passive houses,
8 for the affordable market

Location: Wimbish, Essex

Budget: £1.864m

Standard:
Passive house certified

The ancient Essex village of Wimbish, whose history can be traced to before the Norman invasion of Britain, has cemented its reputation as a hotspot for rural passive house development following the opening of a second major scheme for low-income residents. Hastoe Housing Association, which is behind both projects, has long been a leader in addressing the chronic problem of unaffordable housing in rural areas, as well as local fuel poverty, by building to the passive house standard.

Back in 2011, 'Wimbish 1' became the first rural affordable housing scheme in the UK to gain passive house certification. The enthusiasm of its residents for the 14-dwelling development then persuaded the local parish council to commission a second, similar project.

'Wimbish 2', which opened in June last year, has eight affordable houses for local people, but also three houses to be sold on the open market. "Most people we house couldn't afford to buy a house locally but would never get a look in on the housing register either," says Ulrike Maccariello, development manager of Hastoe Housing Association.

"They're often on low incomes and living with mum and dad, or in privately rented accommodation, which is usually a poor standard and expensive to heat. It's such a financial squeeze they have no money left over. Research also shows how a small amount of additional housing stock can keep schools and pubs open."

Established by the Sutton Dwellings Trust in 1962, the non-profit Hastoe owns and manages more than 7,500 homes in over 70 local authority areas in southern England, from Norfolk to Cornwall. All the homes are affordable housing reserved for local people under the rural exception site rules outlined in the National Planning Policy Framework.

Hastoe began to embrace passive house as a means to reduce rural fuel poverty seven years ago. Management teams took trips to Germany to study the concept, then decided to commission Norfolk-based architectural practice Parsons and Whittley Architects to build Wimbish 1. Since then, Hastoe has built more than 100 passive houses. Passive House Plus has previously featured various Hastoe schemes across Norfolk and Essex.

According to Hastoe, even when its new developments do not achieve passive house certification, the majority reach the AECB Silver standard, which is based on the same design principles and also uses the passive house software PHPP to calculate performance.

At the time of Wimbish 1, aiming for the passive house standard felt like a radical step for Hastoe as hardly anyone ▸

> Hastoe report that rent arrears have been all but eliminated on their passive house projects, and that void rates between tenancies are substantially lower.

CONSTRUCTION IN PROGRESS

1 Laying the self levelling sand and cement screed for the foundations; **2** the rising walls with Thermalite aircrete blocks at the base to minimise thermal bridging; **3** 200mm of PIR insulation to provide insulation under the ground floor.

CONSTRUCTION IN PROGRESS

1 XPS insulation fitted to the wall cavity below damp-proof course (DPC); **2** plywood door box rising from the DPC layer below; **3** 250mm cavity fully filled with Earthwool mineral wool cavity slab insulation; **4** low thermal conductivity Teplo basalt wall ties connecting external leaf of brick with internal Thermalite aircrete blocks; **5** Foamglas Perinsul structural insulating blocks at door threshold; **6** Earthwool extending from wall cavity up into eaves.

> Back in 2011, Wimbish 1 became the first rural affordable housing scheme in the UK to gain passive house certification.

in the village had heard of the concept. "It's normally a lifestyle choice, but these residents had no choice. These were the only houses available. They were being asked to move into homes with only one radiator, so we had to do a lot of explaining and educating about passive houses," Maccariello says.

An ongoing evaluation of Wimbish 1 by the Technology Strategy Board, and the University of East Anglia, has shown that most residents are using 90% less energy to heat their homes relative to building regulations, and have average heating bills of just £120 a year.

Feedback has been universally positive. "They were used to ex-council houses that can be draughty, and having to put money aside to pay bills," says Maccariello. "Now they say they can afford holidays for the first time and they can spoil the kids at Christmas. It's also about comfort as when people can't afford to turn the heating on; they get issues with condensation and damp." Hastoe have also reported that rent arrears have been all but eliminated on their passive house projects, and that void rates between tenancies are substantially lower, with tenants less inclined to move out.

Chief architect Chris Parsons says Wimbish 2 has a somewhat different design to Wimbish 1. It had to have commercial appeal, he says, because of the houses for sale on the open market. "The British tend to be quite traditional in their taste so Wimbish 2 has a brick finish and a more traditional look, whereas Wimbish 1 was more contemporary in feel," he says.

The experience of designing the cavity wall Wimbish 1, followed by a series of other passive houses, has convinced Parsons that it is possible to achieve the standard using materials and methods that are familiar to the UK construction industry. "We used things the industry is dealing with every day including pre-cast beam and block floors, traditional strip footing and cavity walls. It makes it easier for them to deliver the standard, and it's more likely to keep costs down."

The external walls are finished with facing ▶

Photography: Parsons & Whittley

> Research shows how a small amount of additional housing stock can keep schools and pubs open.

brickwork and small areas of larch cladding, and there are wide, insulated cavities of 250mm. The roofs are timber trusses infilled with high levels of insulation. The largest affordable home in Wimbish 2 is a 106 square metre four-bedroom house, but there are smaller units with one, two and three bedrooms.

Parsons is delighted with Wimbish 2. "It's proved we can deliver passive house in a number of different vernaculars, using a variety of construction methods. It's also exceptionally satisfying as an architect to know the residents will cut their heating bills right down. No one should have to scrimp on other expenditure to get a warm and comfortable home. But the fact is that the UK industry is still building too many homes that don't deliver the same level of comfort," he says.

SELECTED PROJECT DETAILS

Client: Hastoe Housing Association
Architect: Parsons & Whittley Architects
Main contractor: DCH Construction
M&E engineer: Alan Clarke
Civil engineer: Donald Hall Associates
Structural engineer: Ken Rush Associates
Passive house certifier: Mead Energy & Architectural Design
Quantity surveyors: AECOM
Mechanical contractor: Bentley Mechanical Services
Electrical contractor: Kim Daplyn Electrical Services
Airtightness testing: Anglia Air Testing
Cavity wall insulation: Knauf
Additional wall insulation: DOW Building Solutions
Airtight OSB: SmartPly
Thermal breaks: Ancon
AAC blocks: Forterra / Ytong
Foamed glass blocks: Pittsburgh Corning UK Ltd
Floor insulation: Celotex
Airtightness products: Ecological Building Systems
MVHR: Green Building Store
Windows & doors: Ecohaus Internorm
Clay roof tiles: Sandtoft
Boilers: Worcester Bosch
Radiators: Stelrad

CONSTRUCTION IN PROGRESS

1 Airtightness membrane rising up over the internal leaf of the cavity wall, under the joist hangers; **2** foam for airtightness where joist ends meet the airtightness membrane; **3** airtightness taping behind timber studs; **4** Smartply ProPassiv airtight OSB with tapes and service void at first floor ceiling; **5** airtightness taping at ply window box; **6** taping at service penetrations and wall-floor junction.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AWARD WINNING PASSIVHAUS PROJECT - CARROWBRECK MEADOW
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IN DETAIL

Building type: Scheme of eight affordable housing units & three open-market units, all passive house certified and of cavity wall construction. Affordable units comprise two 1-bed, four 2-bed, one 3-bed and one 4-bed units. Three 3-bed open-market units.

Location: Munson Mill Close, Wimbish, Saffron Walden, Essex

Completion date: June 2016

Budget: £1,864,000

Passive house certification: Certified

Space heating demand (PHPP): 14 kWh/m^2/yr

Heat load (PHPP): 10 W/m^2

Primary energy demand (PHPP): 92 kWh/m^2/yr

Heat loss form factor (PHPP): 3.137 (average across the site)

Overheating (PHPP): Less than 5% of time (overheating risk)

Environmental assessment method: Code for Sustainable Homes – level 4

Airtightness (at 50 Pascals): 0.42 ACH (average across the site)

Energy performance certificate (EPC): B 84 (average across the site)

Energy bills: Estimated to range from £35-65 per year depending on house size for space heating only (using PHPP data and gas price of 4.3p per kWh, not counting levies or standing charges).

Thermal bridging: Low conductivity Thermalite aircrete blocks used for inner leaf above beam & block floor level; low conductivity Ytong aircrete blocks used within the beam & block floor construction; deeper precast beams to the ground floor to span full width of the dwelling (likewise first floor joists), to avoid internal foundations/supporting walls and in turn further thermal bridges through the ground floor construction; low thermal conductivity (basalt) cavity wall ties; all wall insulation taken 215mm below the ground floor insulation and gables fully insulated; thermally broken window frames with plywood boxed cavity closers and highly insulated reveals/sills/head; Foamglas Perinsul structural insulating block to window sill; Y-value based on defaults (stated within PHPP & ACDs England)

Ground floor: (top down) 65mm self-levelling sand/cement screed; polythene separation and airtightness membrane, lapped and sealed to external walls with pro clima airtightness products, 200mm PIR insulation (0.022 W/m^{2}K), polythene damp and airtightness membrane; proprietary suspended beam & block floor construction; ventilated void. U-value = 0.102 W/m^{2}K

Brick clad walls: 102.5mm Brickwork followed inside by 250mm cavity fully filled with Earthwool DriTherm 32 mineral wool cavity slab insulation (0.032 W/m^{2}K) and low therm Teplo basalt wall ties. 100mm Thermalite aircrete block (0.15 W/m^{2}K) to form inner leaf with 13mm Gypsum plaster finish (Solitex membrane lapped and sealed at all junctions with pro clima airtightness products). U-value: 0.115 W/m^{2}K

Timber clad walls: 20mm Siberian Larch horizontal profiled cladding (untreated) on 38mm treated timber battens (ventilated void), on 100mm Thermalite aircrete block (0.15 W/m^{2}K), on 250mm fully filled cavity with mineral wool insulation (0.032 W/m^{2}K) and low therm Teplo basalt wall ties. 100mm Thermalite aircrete block (0.15 W/m^{2}K) to form inner leaf with 13mm Gypsum plaster finish (Solitex membrane lapped and sealed at all junctions with pro clima airtightness products). U- value: 0.109 W/m^{2}K

Roof: 12.5mm plasterboard internally, followed above by 38mm battened service void, 12.5mm SmartPly ProPassiv OSB vapour control layer (airtight sheathing, lapped and sealed at all junctions/joints with pro clima airtightness products), 500mm Earthwool Loft Roll 40 mineral wool insulation (0.040 W/m^{2}K), pre-fabricated timber trusses, vapour and air permeable roofing underlay, 25mm timber tile battens, clay pantiles and plain tiles to porches. U-value: 0.08 W/m^{2}K

Windows: Pre-finished aluminium/uPVC composite Internorm Home Pure KF410 triple glazed range, supplied by Ecohaus Internorm. Sealed at all junctions with pro clima airtightness products. U-value: 0.73-0.74 W/m^{2}K

Entrance doors: Internorm Home Pure KF410 timber-aluminium composite door. Overall U-value: 0.85 W/m^{2}K

Heating system: Worcester Bosch Greenstar compact combi 28CDi and 36CDi compact gas boilers. Worcester Bosch Greenstar Comfort I RF twin channel programmers on boilers and room thermostats in kitchen/dining room. Stelrad Elite double convector radiators in kitchens and single convectors in living rooms (double in 4-bed property), with Stelrad straight ladder towel rail in bathroom and en-suite.

Ventilation: Paul Focus 200 (1-2 bed properties) and Paul Focus 300 (3-4 bed properties) passive house certified MVHR units. Lindab safe seal/click ducting throughout all properties.

Water: Consumption to each property is limited to 105 litres/person/day in accordance with Code for Sustainable Homes Level 4. Water butts in gardens to each property.

Green materials: All key elements within the building fabric achieve between a BRE Green Guide 'A+ to B' rating, 80% of all materials used on the development are sustainably sourced & 100% of the timber used on site is sustainably sourced according to the architects, 100% of the insulating materials are to have a global warming potential (GWP) of less than 5, boilers to each dwelling with Dry NOx Levels ≤70 (boiler class 5). ■

£200/yr

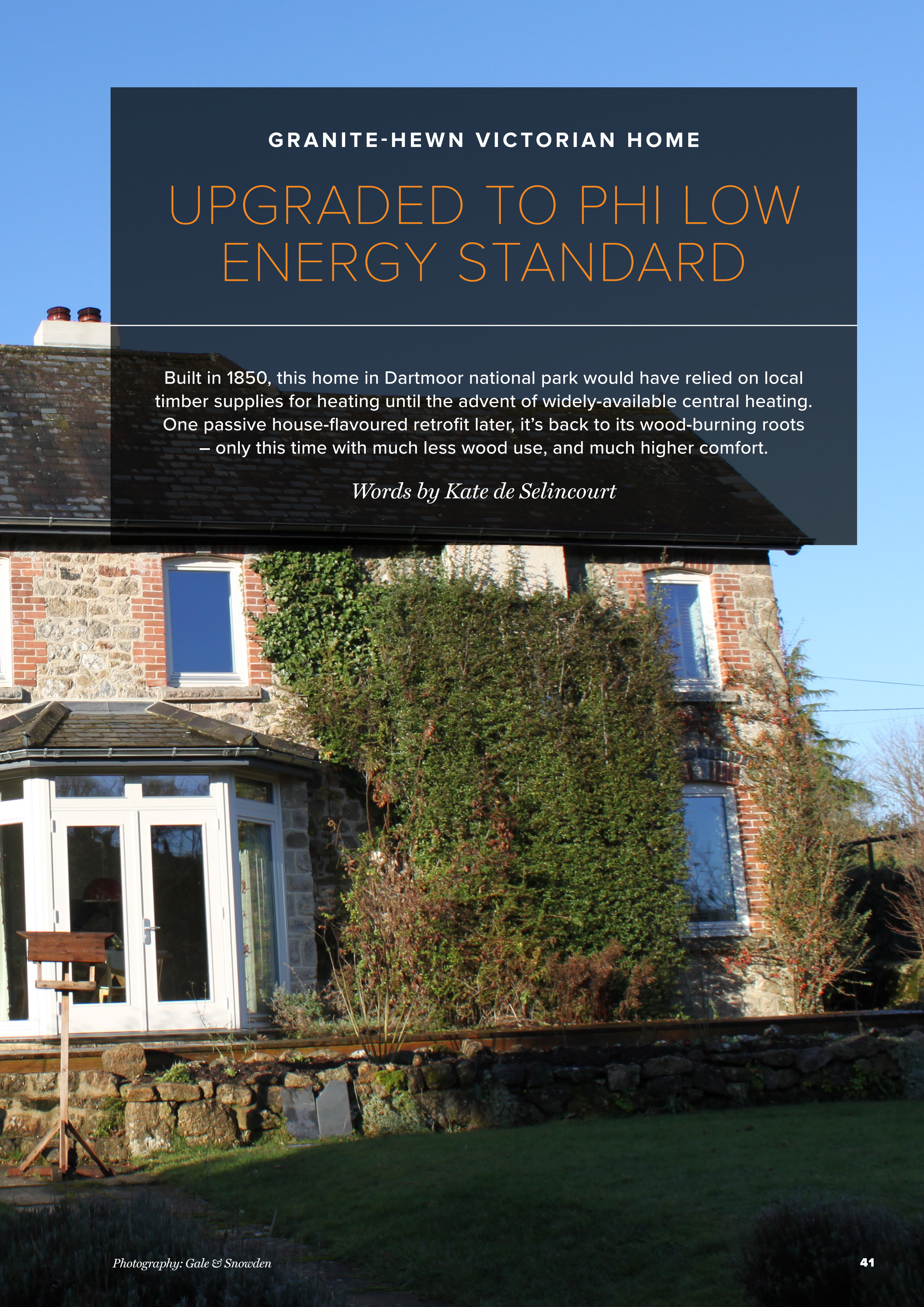
Estimated heating costs – though the house is mainly heated by client's own free timber

Building type: 246 sqm Victorian detached house

Location: Dartmoor, Devon

Budget: £200,000

Standard: PHI low energy building



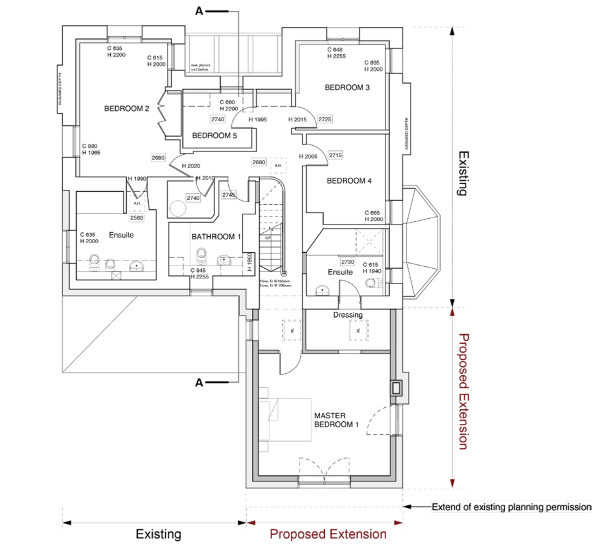
GRANITE-HEWN VICTORIAN HOME

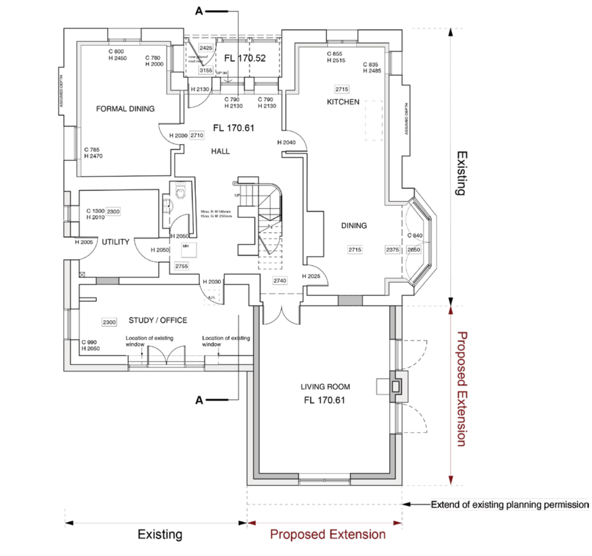
UPGRADED TO PHI LOW ENERGY STANDARD

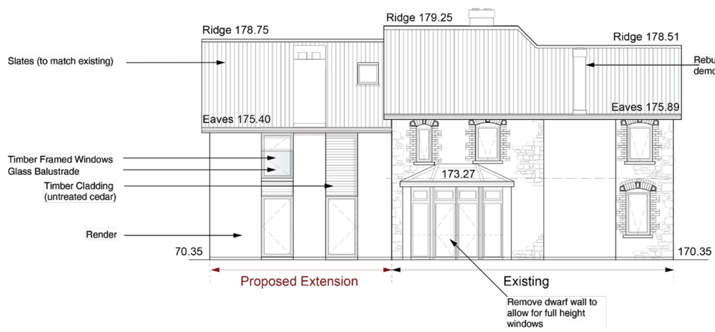
Built in 1850, this home in Dartmoor national park would have relied on local timber supplies for heating until the advent of widely-available central heating. One passive house-flavoured retrofit later, it's back to its wood-burning roots – only this time with much less wood use, and much higher comfort.

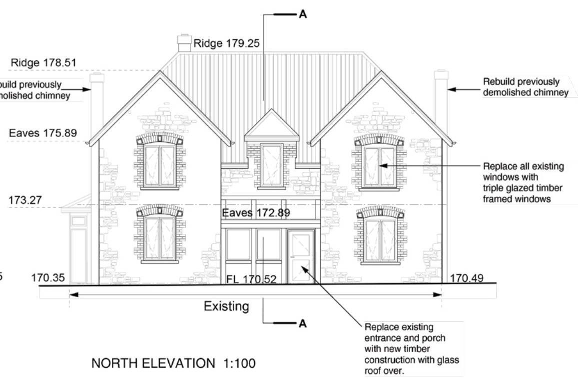
Words by Kate de Selincourt

Photography: Gale & Snowden









CONSTRUCTION IN PROGRESS

1 Airtightness detailing and plastering at joist ends; **2** SmartPly OSB to interior of new roof build-up with airtightness taping around joists; **3** plastering for airtightness around plug sockets; **4** internal taping around the new Viking triple glazed windows; **5** additional taping at joist ends and junctions; **6** mineral fibre insulation in the existing roof, with EPS insulation installed above.

So you've got an irregular-shaped stone-walled Victorian house, subject to the strict planning criteria of a national park – with the added complication of a protected bat colony in the roof. Sited on the north-facing side of a frosty and often-foggy valley, with a client who does not want to be bothered with certification – and a builder who had never tackled a passive house contract before.

If you wanted to end up with a passive house certified home, perhaps you wouldn't start from here? Well, the beauty of passive house is you can start from anywhere, and still end up with a warm, comfortable home with dramatically reduced energy consumption.

And so it has proved with the retrofit of this large detached house taken on by architects Gale & Snowden and contractor Building Devon, with the brief to completely overhaul the fabric and services and add a two-storey extension. And the house is now certified as a 'PHI low energy building' (in fact it was the first to be certified to this standard in the UK).

Located near Chagford on the edge of Dartmoor, with spectacular views towards Castle Drogo and the rolling hills of Devon, the main part of the house dates back to the 1800s, complete with 500mm solid granite exterior walls. There was also a 1990s extension, built with the standard block cavity construction of the time.

The house was one of a long line of retrofits the client had carried out. He had always been interested in the sustainability of these projects, and in 2010, for this retrofit, he enlisted the help of Gale & Snowden Architects.

At that point Gale & Snowden themselves were relatively new to passive house, but one of their first passive house projects, the 18-flat development at Knights Place in Exeter, was on site, so the architects took the client for a visit. As project architect Tomas Gartner recalls: "We explained the principles of what we were doing there and the client was very interested in achieving the building and comfort standards, though at that stage he did not want to go for certification."

Gale & Snowden carried out the design as you would for a certified retrofit – modelling the fabric heat loss in PHPP, prioritising airtightness, carrying out thermal bridge analysis, and specifying heat recovery ventilation. "The client was on board with how passive house works, that it is all based on physics, and he was really comfortable with numbers, so PHPP was useful to communicate about the implications of different choices and decisions, and we were able to keep him in the loop where we were moving towards or away from the Enerphit level performance, so he could be involved easily in all the decisions."

DESIGN

The house was not in bad condition structurally, but with its uninsulated stone walls and 20-year-old oil-fired heating system, it was ripe for an upgrade.

The location in the Dartmoor National Park – with a 100-page design guide to follow – obviously added constraints to the project. Luckily the team were able to find triple glazed timber windows that the national park planners were happy with, and that weren't too expensive. Unsurprisingly, external insulation was not permitted on the visible granite walls, meaning internal insulation had to be used quite extensively.

"For the internal insulation we used mostly mineral fibre insulation (150mm packed into timber studwork). Upstairs, where the rooms are quite small, the client opted to use Aerogel in order not to lose space – the Aerogel saved around 100mm," Gartner says.

There were in theory two options for wall airtightness, outside and inside. One possibility was to repair the granite walls, and make the masonry and the rendered sections continuous with the slab and the airtight layer in the roof. The alternative was to go inside.

Although this second option might appear more disruptive, as the team needed to cut back floors and ceilings to ensure continuity, "it meant that the airtightness and vapour control layers are the same, so no warm moist air can get behind the insulation to meet the cold masonry, which with internal insulation I think is very important," Gartner says. He also notes that achieving airtightness in a rubble-cored traditional stone wall might have been quite tricky.

The new extension and the existing rendered walls were externally insulated with EPS. This delivered lower U-values than the internal insulation (around 0.13 W/m²K, as opposed to 0.2 W/m²K), thus improving the overall energy performance.

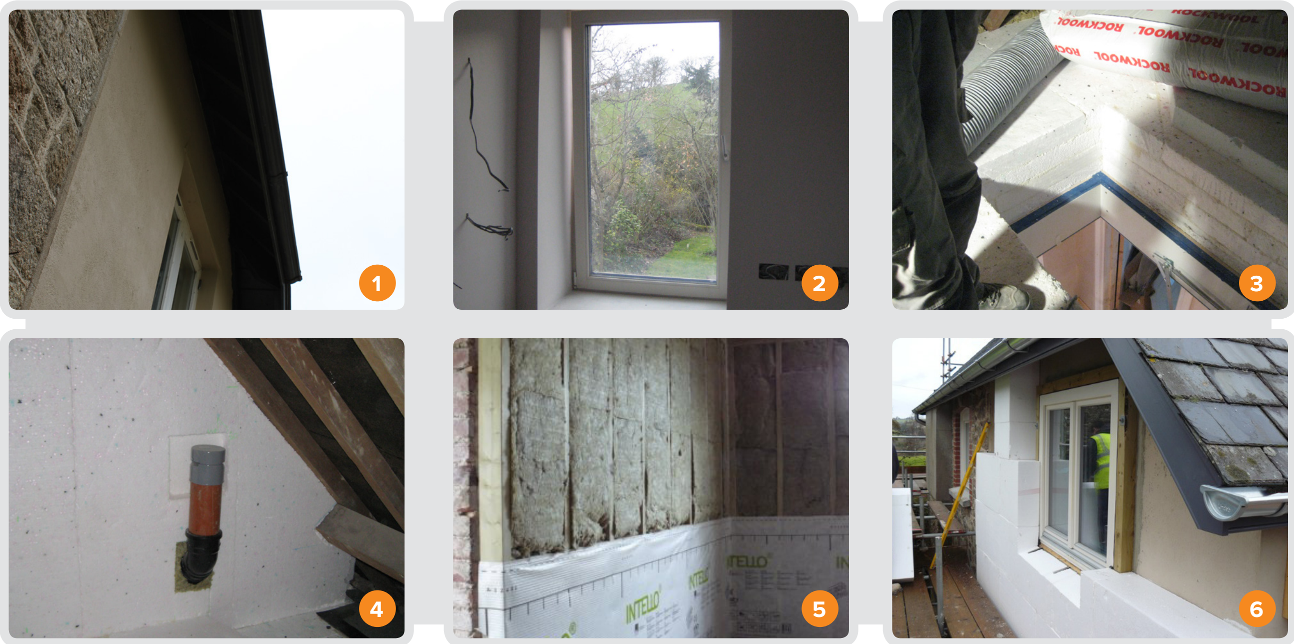
BUILD

When contractor Building Devon were taken on for this project, they had never worked on a passive house project before. But Tomas Gartner says they did "an incredible job, really meticulous." Gale & Snowden have since worked with them on two more builds.

Barry Webb from Building Devon found the passive house approach made sense immediately. "What we liked about passive house was the attention to detail when it comes to making a building airtight and thermally efficient. Once you understand the concept you forever see ways air can get into the building, and stopping it almost becomes an obsession. This level of construction is well above the current building regs and just makes sense if you want to conserve energy."

They also appreciated the sound basis in ▸

CONSTRUCTION IN PROGRESS



1 The existing walls before the upgrade work — the depth of the eaves allowed for external wall insulation over the existing rendered walls; **2** new Viking 3E triple glazed aluclad windows; **3** 600mm EPS insulation over joists at ceiling level, and airtight taping around attic hatch; **4** an existing load bearing wall was clad with 100mm EPS on both sides to reduce thermal bridging; **5** solid stone wall externally followed inside by mineral fibre insulation and vapour control layer; **6** the existing rendered walls were externally insulated, but this was not permitted on the visible granite walls.

science and mathematics: "We found it very interesting that the knowledge and computer modelling is able to determine the building's efficiency, and if insulation is reduced in one area it can be increased in another to offset. This is especially important on a retrofit where space can be limited."

In turn, Building Devon used their practical understanding of what works in construction to make a number of valuable suggestions, Tomas Gartner says. "What I particularly like about Building Devon is their intelligent approach to sequencing."

"They are always looking ahead to the next step. For example, we had proposed a taped membrane for the ceiling airtightness layer, but they pointed out that by using OSB instead, this could be taped from above – the site crew would have a platform to work straight onto, making it much easier to deliver excellent airtightness.

"It's always worth being open to contractors' suggestions: the contractor will always have something to bring."

SERVICES

Hot water comes from a large thermal store heated primarily by solar thermal collectors, with back-up from an immersion heater.

The client was a great fan of wood stoves, and wanted to install not one but three, to make use of their own timber supply. One stove was installed as the main source of space heat in the central open hallway. A second stove went into the living room, then a wood-fired range cooker in the kitchen diner.

"A stove in the kitchen is potentially tricky because the room is under extract, so you have to be extremely careful that there is no chance of CO contamination," Gartner says. "However we found an Austrian model that is airtight enough to use in a passive house, and of course also installed carbon monoxide alarms as required in the regs."

The wood stoves are supplemented by three electric towel rails. For the purposes of primary energy calculations the team and certifier between them settled on the prediction of an 80:20 split in favour of wood. The client estimates that the electric heating gets used less than this – although as the wood isn't purchased, there aren't records as such.

HEAT LOAD & CLIMATE

Chagford's nearest weather station is only 30 miles away in Exeter. However Exeter's climate is very different from Chagford's: it is close to the sea in a sheltered south-facing valley, where it rarely drops below 5C. Chagford by contrast is on the north-facing side of the high Teign valley, prone to frost and, not infrequently, fog. "The house is in a spectacular location, the views are amazing – however, the orientation of the site means the daily window for solar gain is shorter," Gartner says.

"In order to get the best possible predictions, we did try to get more local weather data to input into the calculations, but nothing was available in the right format. Instead we used the Exeter data, adjusted for elevation.

"In these kind of locations we always exercise caution, and oversize the heating system a bit compared to the predicted load in PHPP: we've completed a number of passive houses in Devon now, and so far they've all been comfortable and the energy use has been within predictions."

WUFI

Although the client was not interested in certification at the time, around five years later, when they decided to sell, they decided a third-party-accredited standard offering quality assurance would be useful to demonstrate to prospective buyers the quality of what they were buying – so Gale & Snowden went back to the project to organise certification. The certification process flagged up the need for dynamic moisture analysis.

As Tomas Gartner explains: "When I did my passive house training in 2009 – not long before we began this project – there was no mention of hygrothermal calculations." There is also no statutory requirement to carry out dynamic hygrothermal calculations when specifying internal wall insulation, though the current standards are under review.

Instead, the team looked at the moisture safety of the build-ups using Glaser steady state condensation risk analysis, trying to be as rigorous as possible – including asking the manufacturers of the insulation and membranes to supply their calculations.

"As certification didn't happen until after the build was complete, we couldn't really go back to the manufacturers and ask them to supply Wufi calculations for us," Gartner

points out. "But as the client was keen to go ahead with certification, he employed Joseph Little at Building Life Consultancy to do it."

The biggest issue when carrying out Wufi calculations is often getting the right material property data to input. While some materials are quite well characterised and consistent – fired blocks for example, the specific hygrothermal properties of the materials in a traditional building using natural stone from a local quarry are a lot less clear. Yet relatively small differences can make a significant difference to the predicted performance.

The Dartmoor granite this house was built from turned out to be quite unlike the hard, impermeable type of granite that you would find in northern Britain and Scandinavia; called "Chagford gold", it is softer and more porous with a relatively high lime content. Building Life Consultancy reviewed the available technical literature and compared it with materials from the Wufi database, in order to arrive at the closest possible data match to input for the calculations.

The porous nature of the stone means that driving rain will penetrate more deeply, but it also makes the wall more forgiving of temporary condensation, Gartner says, so in the end it turns out to be beneficial as the masonry is better able to regulate moisture.

Happily, all the build-ups passed the assessment. Although of the materials used internally the mineral wool is the more vapour open, perhaps counter-intuitively in the dynamic calculations the Aerogel – which is quite hydrophobic but still vapour-open – was the further into the safe zone of the two (of course mineral wool is a great deal cheaper).

BATS

Early investigations of the roof revealed a very thick layer of bat droppings – and as bats are a protected species, this determined the decision to insulate and make the roof airtight at ceiling level, leaving the bats free to come and go as before – though now through dedicated bat access points rather than just cracks and gaps.

As Barry Webb recalls, they had to allow the bats to come and go through their original entry points under the eaves by creating slots in the wall and roof insulation, which they lined with roofing felt. "Essentially, there are built in cold bridges to satisfy and preserve the bat colony!" he says.

None of this could be done while the bats were at home; as it is a winter roost, work on the roof had to wait until the colony had moved out for the summer. Webb adds that: "the client was concerned about the bat effluent, which is very smelly, permanently soiling the insulation, so a layer of plastic sheeting was laid over the top and large plastic containers with cat litter placed under their roosts." An airtight loft access hatch was installed, which gives access to the roof space for any maintenance requirements, and to clean up after the co-residents!

CERTIFICATION

Gale & Snowden's design had originally aimed for the Enerphit target. However between the build and the decision to certify, south-west England was reclassified from a 'cold temperate' to 'warm temperate' climate by the Passive House Institute, making the energy target for Enerphit more demanding (requiring a maximum annual heat demand of 20, not 25 kWh/m²/yr, to qualify).

Because Enerphit was no longer an option, the house became the first in the UK to be certified to the then-new PHI low energy building standard. To qualify, a building must achieve a high level of energy efficiency and a high degree of user satisfaction, as well as protection against condensation damage, as with the passive house and Enerphit standards, with an annual space heat demand at or below 30 kWh/m²/yr, airtightness at or below one air change per hour, and a primary energy demand (renewable) of below 75 kWh/m²/yr.

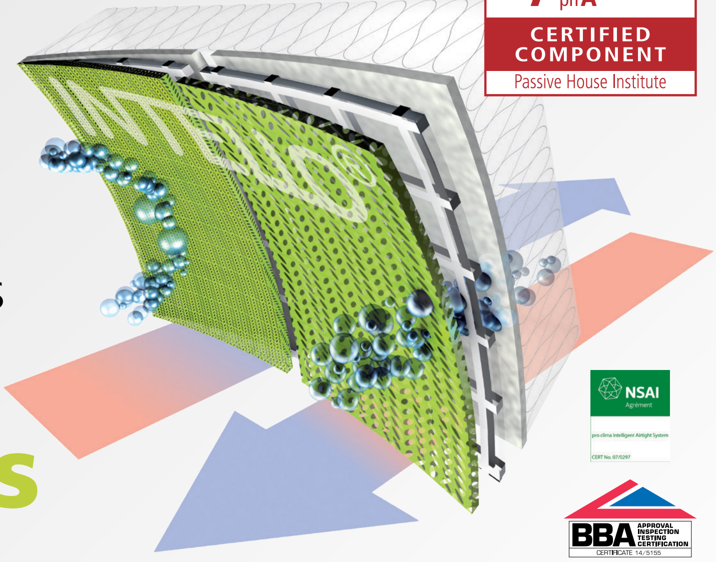
Since this early passive house project Gale & Snowden have gone on to embrace the standard and they now specialise in passive house, and Building Devon too have gone on to carry out new builds and conversions to passive house standards. Barry Webb says they learned a lot from this first project – not least about the inferior way almost all other houses are built and refurbished.

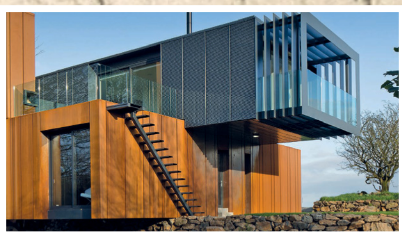
"When building to passive house standards you learn a lot, and realise there is a whole other way of building and with the numerous advances in materials a building can be so much more than a leaky, cold, inefficient dwelling. It makes you realise that the building industry is years behind in this country and needs a serious shake up.

"We have gained an enormous amount of knowledge on how to improve the work we do, and are able to put that knowledge into action on all our projects, and hopefully help the future of our planet and the environment around us."

SELECTED PROJECT DETAILS

Architect: Gale & Snowden
Civil & structural engineer: Barry Honeysett
Main contractor: Building Devon
Airtightness testing: JSD Air & Acoustic Testing
External insulation: SAS
Internal wall insulation: Rockwool
Additional wall insulation: Aerogel
Roof insulation: Jablite / Knauf
Airtightness products: Ecological Building Systems
Windows & doors: Viking, via Ecomerchant
Solar thermal: Megaflo
Heat recovery ventilation: Zehnder, via Aereco
Chimney system: Schiedel





IN DETAIL

Building type: 1850 Victorian detached house. 246 sqm treated floor area.

Location: Dartmoor, Devon

Budget: £225,000

Space heating demand (PHPP): 30 kWh/m²/yr (certified PHI low energy building)

Heat load (PHPP): 15 W/m²

Overheating (PHPP): 0%

Primary energy demand (PHPP): 104 kWh/m²/yr

Energy performance certificate (EPC): A 93

Heating costs: Estimated at under £200 per year. Based on 20% (6 kWh/m²/yr) of the building's calculated space heating demand provided by three electric towel rails, assuming a price per unit of £0.13p. The client's own free wood supply provides the balance.

Airtightness (at 50 Pascals): 0.7 air changes per hour

ORIGINAL WALLS
Before:
Solid granite stone wall. 1960's concrete cavity wall with 50mm EPS insulation.
After:
Wall type A: Solid stone wall externally followed inside by 100mm mineral fibre insulation, vapour control layer, service void with 50mm mineral fibre insulation, plasterboard and skim.
U-value: 0.224 W/m²K
Wall type B: Solid stone wall followed inside by 54mm aerogel insulation, VCL, OSB board, plasterboard and skim.
U-value: 0.215 W/m²K
Wall type C: 6mm render externally followed inside by 250mm Neopor insulation, concrete cavity wall with 50mm EPS insulation, plaster. U-value: 0.109 W/m²K

EXTENSION WALLS
Wall Type E: 6mm render externally, followed inside by 250mm Neopor insulation, concrete blocks laid on flat, plaster. U-value: 0.130 W/m²K
Wall Type F: 22mm cedar cladding externally, followed inside by 38mm ventilated void, weather membrane, 250mm mineral fibre insulation, 100mm concrete block, plaster. U-value: 0.137 W/m²K

EXISTING ROOF
Before: Uninsulated cold roof with slate finish.
After: Insulation at ceiling level: 600mm EPS, OSB board, mineral fibre between existing joists, plasterboard and skim/plaster and lath.

Extension roof: I-joist timber roof with mineral fibre insulation: local slates externally on 38/25 battens/counter battens, followed underneath by breathable roofing underlay, 365mm timber I-joists fully filled with mineral fibre insulation, 12mm taped & sealed SmartPly OSB, 38mm insulated service cavity, 12.5mm plasterboard and skim ceiling.
U-value: 0.11 W/m²K

WINDOWS & DOORS

Before: Single glazed, timber windows and doors. Overall approximate U-value: 3.50 W/m²K

After and extension: New Viking 3E triple glazed, aluclad windows and doors: Average overall U-value of 0.95 W/m²K

Roof windows: Velux triple glazed roof windows. Overall U-value: 1.0 W/m²K

HEATING SYSTEM
Before: 20 year old oil boiler & radiators throughout entire building.
After: RIKA Vitra (with externally insulated Schiedel Isokern pumice chimney system in extension), Nester Martin, and Lohberger woodburning stoves, MEGAflo solar thermal system including 2.34 sqm flat plate array and thermal store.

VENTILATION
Before: No ventilation system. Reliant on infiltration, chimney and opening of windows for air changes.
After: Zehnder ComfoAir 350 — Passive House Institute certified to have heat recovery rate of 83%.

Green materials: Local slate and timber, natural paints and pure solid hard oils, no PVC, all timber furniture from FSC certified sources.

THE DAZZLING DALKEY HOME WITH A

HIDDEN ECO AGENDA

Even in the era of climate change, there still appears to be something of a split in the world of architects between those who prioritise sustainability, energy efficiency and occupant health, and those who put design and aesthetics first. So it's refreshing to find that the designer of this contemporary Dublin home put so much attention on insulation, airtightness and indoor air quality — as well as good looks.

Words by Jason Walsh

€214

(gas & logs)
estimated space heating costs

Building type: 145 sqm block-built house with external insulation

Location: Dalkey, Dublin

Budget: €300,000 (ex VAT)

Standard: Low energy house / A3 energy rating

Photography: Richard Hatch Photography

Self-building doesn't always make a great deal of sense, at least not from an economic point of view. Why go to the trouble of designing a unique house when you can just buy one? Unless, of course, design is the entire point.

This was the case for homeowner Maureen, who has recently moved into her remarkable new home in Dalkey, County Dublin. "The contemporary style is what I wanted, and I always assumed that would be more energy efficient," she says.

Compared to ageing Georgian or Victorian housing stock — or even some Celtic Tiger homes — this is certainly true, but modern design does not necessarily mean energy efficiency is guaranteed. Indeed, it can often be sacrificed in the name of design elements: principally vast expanses of glass, and angles that create thermal bridges.

She says: "I suppose my parents built their own house, and my sister built her own house [too]. Even though I [initially] bought a house, it wasn't what I wanted. I didn't want to see myself in a cookie-cutter house. Building a house, you build it to exactly what you need and the architect's interpretation of your vision."

In fact, Maureen located the site first, and the house she subsequently commissioned has significant site-specific elements. In particular — though it will never be mistaken for a bungalow — it addresses the street as a single-storey building, while at the rear sloping ground allows it drop down to a second storey.

Much like a sympathetic contemporary extension to a more traditional building, then, and while it doesn't ape the other homes around it, it does take account of the overall streetscape.

> "I like that what you see isn't all that you get.

"I bought the house for the aspect and the garden," says Maureen. "I could see the potential in the site. In the original bungalow [that was on the site] you could see there was a lot that could be done, but I wasn't as conscious that the view was as good as it is."

Because of this view from the rear of the house Maureen now feels that the house has a double aspect: a relatively straightforward facade addressing the street in a sympathetic manner, and a more dramatic two floors over the slope at the rear. "I like that what you see isn't all that you get," she says.

Diarmaid Brophy started as project architect with Sterrin O'Shea Architects, but took over full responsibility for the build when Sterrin herself relocated to Britain. Though possible, a refurb of the original bungalow was never really on the cards.

"Ultimately, Maureen wanted a low energy home, and wanted it to be as low energy and low maintenance as possible while still adhering to her aesthetic criteria," says Brophy.

"There was an existing bungalow on-site. It wasn't occupied [and] it was in a fairly dilapidated state. Dún Laoghaire-Rathdown is quite progressive in terms of energy use [so] we made an argument to demolish it and start from new.

"Aside from the design point-of-view, working with the existing house and all the restraints that that would involve would have incurred a lot more expense," he says. "Although the energy requirements aren't quite as strict as when you're doing new build, it would have been more expensive."

The decision for a new build made, Brophy set about marrying his client's desire for a house that encapsulated the modern aesthetic while also being modern from the point of view of energy use.

Brophy says: "She knew she wanted a three-bed house, and had ideas of open-plan living and being open to the garden. The site is quite dramatic in that it is on a cul-de-sac, and there's a fall [at the rear] which is quite steep.

"In terms of keeping something that would fit in with the context [of the street] we kept it single-storey on the front and two-storey at the rear."

Energy-wise, Brophy went for 180mm of EPS external insulation on the walls, a heavily insulated roof, an emphasis on airtightness, and heat recovery ventilation,

along with some solar PV.

"For me, it's just the standard now. Clients sometimes need educating, though: they all want an insulated home, but it's not just about insulation. It's also about thermal bridging, and bringing airtightness and a ventilation strategy to things," he says.

Achieving this is, he says, a key part of what an architect does these days — not something to be ignored or left to someone else. "For me, good building is about attention to detail."

The house was commended in the house of year (Dublin) category at the 2017 Irish Architecture Awards.

And Maureen now has a house that is not only eye-catching, but with its low-energy building fabric and emphasis on good indoor air quality, delivers something more than meets the eye.

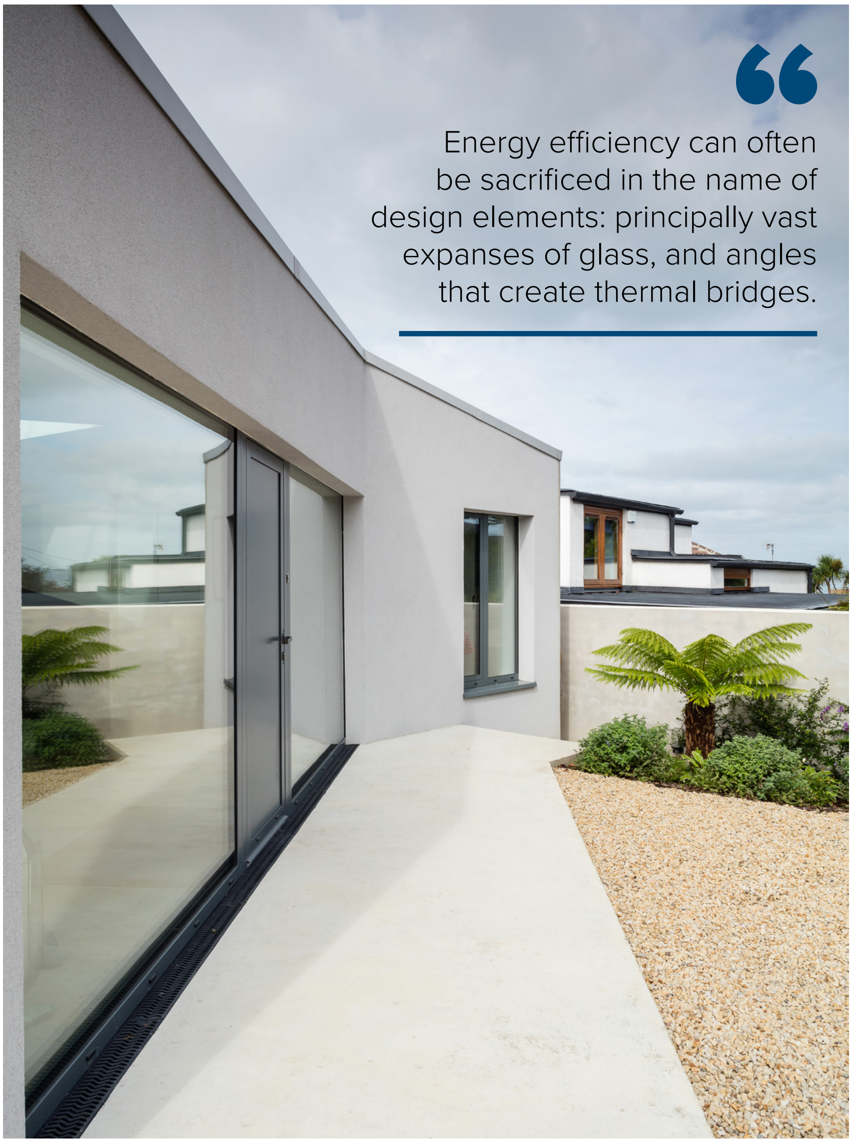
"I remember a friend of mine saying, 'What are you doing? It's not a real house!' she says "Well, I'm so glad it's not a normal house."

Explained:

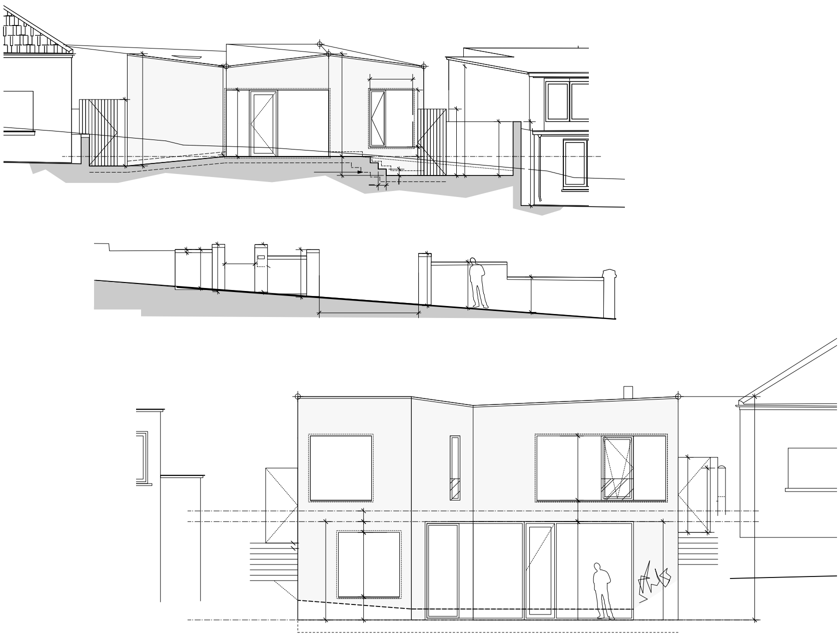
Thermal bridges occur where heat or cold transfers across the external surface of a building, such as where a building element — like a joist or steal beam — cuts through the insulation layer. These can be significant points of heat loss.

"Maureen now has a house that is not only eye-catching, but with its low-energy building fabric and emphasis on good indoor air quality, delivers something more than meets the eye.

1 Installation of the 300mm Baumit graphite EPS external insulation system onto the 215mm hollow block; **2-3** Xtratherm PIR board, behind the main external insulation layer, to prevent thermal bridging under windows at thresholds.

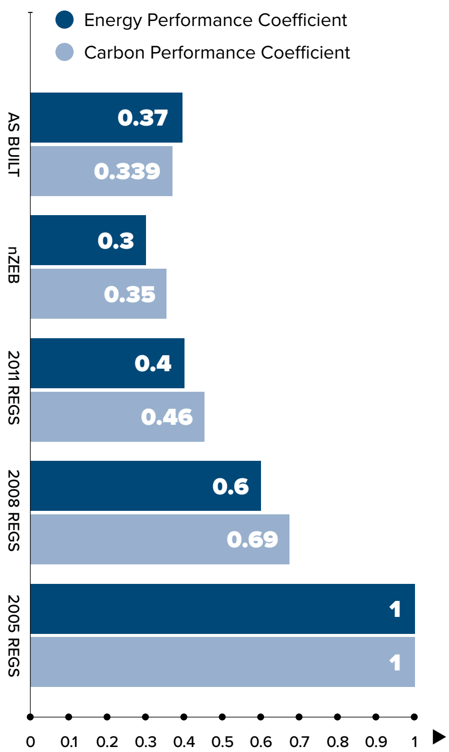


> Energy efficiency can often be sacrificed in the name of design elements: principally vast expanses of glass, and angles that create thermal bridges.



SELECTED PROJECT DETAILS

Architect: Diarmaid Brophy Architects
Main contractor: Sheerin Construction
Civil & structural engineer: Casey O'Rourke Associates
Energy consultancy: Archie O'Donnell
Airtightness test: NER Solutions
Electrical contractor: LT Electrical
Mechanical contractor: EcoScene
External insulation: Baumit
PIR insulation: Xtratherm
Mineral wool insulation: Knauf
Airtightness system: Ecological Building Systems
Windows & doors: Reynaers, via Topline Windows
Roof windows: Fakro, via Tradecraft
Rooflights: Skylight.ie
Heat recovery ventilation: Vent Axia, via Lindab
Solar PV: Solarworld, via Heat Merchants
Stove: Heating Distributors Ltd
Condensing boiler: Greenstar
Rainwater harvesting: Kingspan Environmental





IN DETAIL

Building type: 145 sqm detached house, reinforced concrete/hollow block with external wall insulation

Location: Dalkey, Co Dublin

Completion date: January 2016

Budget: €300,000 (ex VAT)

Passive house certification: N/A

BER: A3 (64.31 kWh/m^2/yr)

Estimated gas use (DEAP, heating & hot water):
6,710 kWh/yr (or 7,382 kWh/yr primary energy)

Measured gas use:
7,110 kWh/yr (Oct 2016 – Sept 2017)

Measured electricity use:
1,642 kWh/yr (Oct 2016 – Sept 2017)

Airtightness (at 50 Pascals):
0.91 ACH or 1.057 m^3/hr/m^2

Estimated space heating costs:
€214 (€162 gas, €54 wood logs).

Estimated domestic hot water costs:
€252 (assuming no immersion use)

Thermal bridging:
0.08 W/mK (Using ACD Details)

Ground floor: 100mm polished finish screed on 125mm Xtratherm, on 200mm concrete slab. U-value: 0.13 W/m^{2}K

Walls: Baumit 30 EPS EWI System with 180mm graphite EPS board, followed inside by 215mm hollow block, 25mm service void formed with 25x50 battens, Intello airtightness membrane, plasterboard, skim finish internally. U-value: 0.17 W/m^{2}K

Roof: Alkorplan (PVC membrane backed with a polyester fleece) externally followed underneath by 170mm Xtratherm FR-ALU, vapour control layer, 21mm WBP, 225x44mm joists with Knauf Earthwool loft roll, Intello airtightness membrane, plasterboard, skim finish. U-value: 0.10 W/m^{2}K

Windows: Triple glazed, argon-filled, Reynaers CS77/CP130LS aluminium system. Overall U-value: 0.85 to 1.17 W/m^{2}K

Roof windows: 3 x Fakro U8 triple glazed, argon-filled roof windows.
U-value: 0.87 W/m^{2}K

Heating system: 90.2% efficient Greenstar 24i condensing gas boiler, supplying underfloor heating throughout. Riva Studio 500 wood burning stove. 4.9 kW, 80% efficient, tested to EN 13229, room sealed with external air supply.

Ventilation: Vent-Axia Kinetic Plus heat recovery ventilation system, SAP Appendix Q rated with a heat exchanger efficiency of 88%.

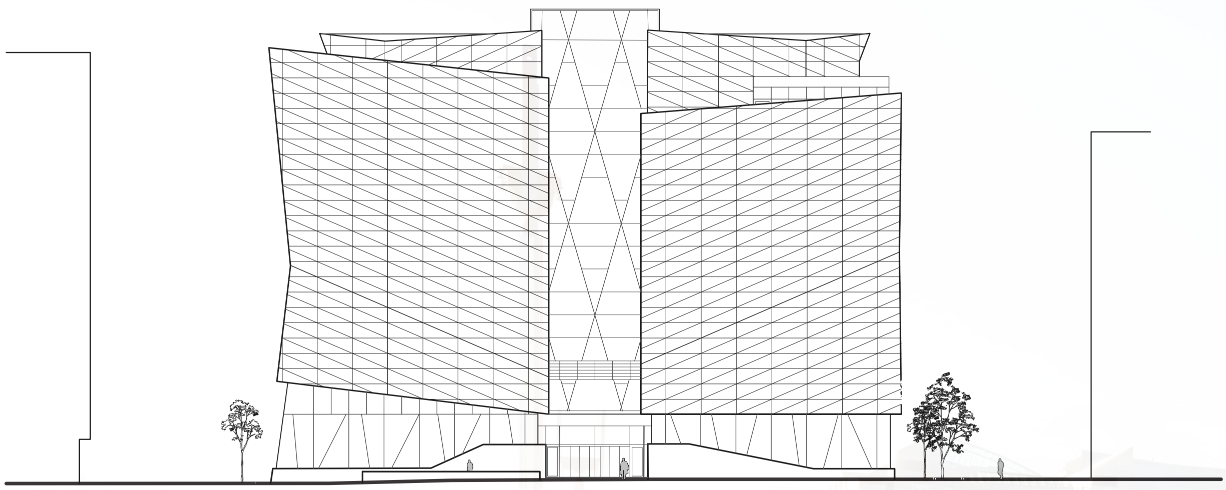
Electricity: 4 x 250W Solarworld Sunmodule photovoltaic panels.

IRELAND'S NEW CENTRAL BANK HITS

NZEB & BREEAM OUTSTANDING ECO RATING

Rising from the shell of the stalled riverside headquarters of Anglo Irish Bank, Ireland's financial regulator could be accused of insensitivity for choosing as its new home a site that became a toxic symbol of the banking crisis, but the building is not without virtue: it comfortably surpasses the proposed nearly zero energy building standard while achieving the onerous Breeam 'Outstanding' rating for sustainability.

Words by Ekaterina Tikhoniouk | Additional reporting by Jeff Colley



Building type: 37,000 sqm public office building

Location: North Quay, Dublin

Method: Glass skin & aluminium mesh panels on pre-existing concrete frame

Budget: €140m

Standard: Breeam Outstanding

After having stood as a bare skeleton for seven years, the eight-storey concrete structure on Dublin's North Quay initially meant for the now-collapsed Anglo Irish Bank has been transformed from the downcast symbol of Ireland's recession into the country's first office building to achieve the highest Breeam sustainability rating, Breeam Outstanding.

Liam McMunn, the organisation's environmental, health & safety manager, explains how the project came about: "One challenge we faced was that when working out of multiple buildings, we found we were operating in silos, with departments not getting to talk to each other as often as they may like. So from an operational perspective we needed to enhance collaboration, and we needed to decant into a single campus." It was no easy task finding an office building big enough for 1,450 employees, and completing the concrete skeleton of a building at North Quay was deemed the best option.

The brief had several key drivers: accessibility, creating a healthy and productive work environment, encouraging collaboration, and achieving ambitious energy and sustainability goals. According to Liam McMunn: "We needed to create an optimum working model for an organisation that has heretofore found itself operating in isolation at times… It was also very important that we created a future-proof building because we know that what's the sustainability target in 2015 is going to be different in 2020."

When you compare this new building with the Central Bank's former headquarters, Sam Stephenson's imposing brutalist tower on Dame Street, it's evident that the organisation has made significant efforts to modernise.

FLEXIBLE, INTUITIVE WORKSPACES

"We were moving from a lot of people having offices and the very hierarchical approach that many public sector organisations inherit to a much more open plan and accessible workstyle," says McMunn. The building was designed very much with its end users in mind — a variety of flexible, intuitive collaboration spaces with different spatial arrangements and furniture types clustered around the building's central atrium, with offices and meeting rooms in the middle of the floorplates and the main desk areas placed alongside the facade, to take advantage of natural daylighting.

There was also a strong focus on inclusive design, and the building's accessibility features enhance the user experience of all staff. "If you create good clear circulation routes, that's good for everybody, not just for the people who have specific needs," he explains.

The new office is also a lot more inviting to the public — the ground floor is open to the public, and includes an exhibition space and three flexible rooms that can host large events.

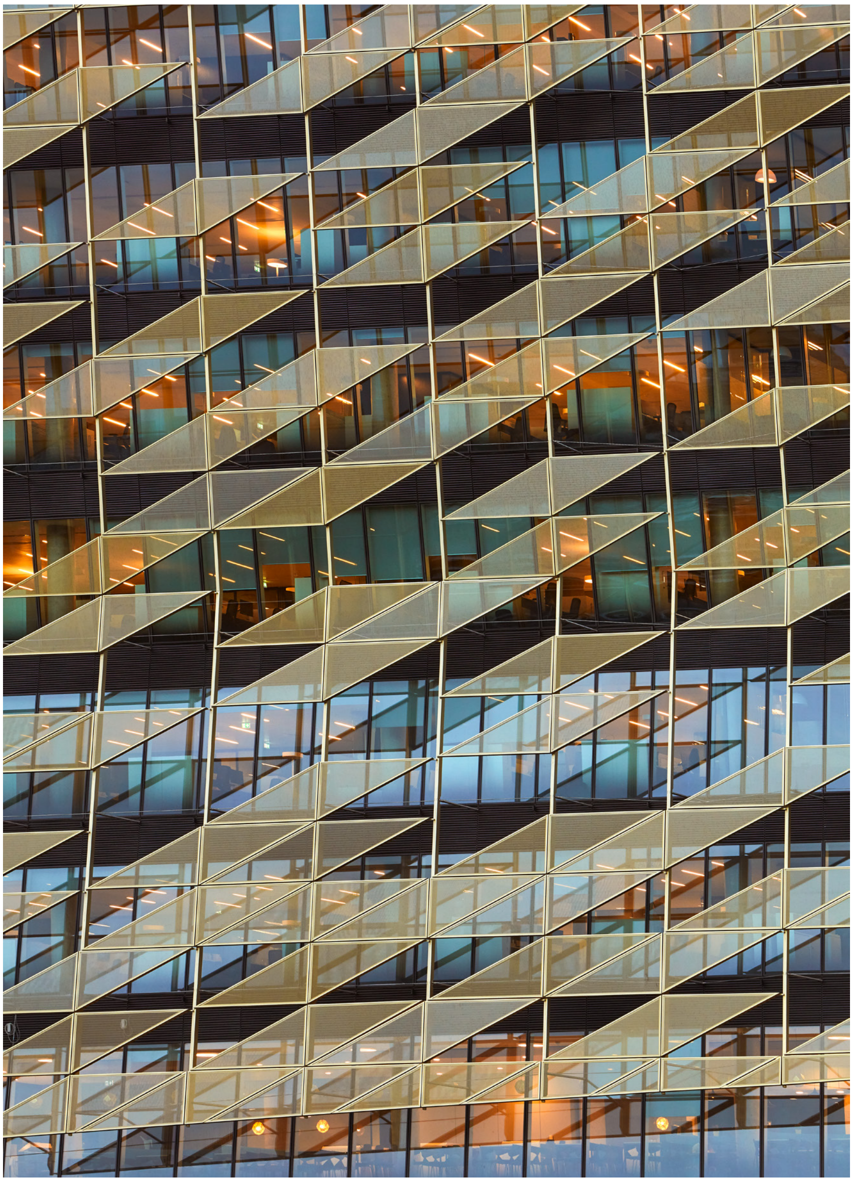
The building has a highly-modern technology setup too. Laptops have replaced desktop computers, and employees can answer their phone from their laptop, or print a document and collect it from any printer in the building, or display slides on a meeting room screen in two clicks.

A laptop can also consume up to 80% less electricity than a desktop computer, a significant energy reduction given there are 1,450 staff in the building. Energy use was reduced in other small ways too, like with sit-stand desks that only have a manual crank to raise or lower them, not a motor. The building's intelligent lift system also saves energy. There are no traditional controls in the lifts themselves, but rather users select their destination floor on controls outside the lifts, and the system works out the most efficient lift to bring to the user.

THE FACADE

The building's outer skin, meanwhile, consists of a glass facade wrapped with a layer of anodized aluminium triangular mesh panels. The density and coverage of the mesh varies depending on its orientation; as well as maximising daylight, it minimises glare and passive solar heat gains, thus reducing the energy needed for cooling.

A unitised system of prefabricated panels was chosen for the glass skin, and facade interfacing was minimised. The team went a step further and brought a full-scale two-storey facade mock-up to a UK testing facility. They carried out rigorous wind, temperature-change, thermal-bridging, water- and airtightness tests on it, even putting a jet engine in front of it.



Pat Kirwan describes it as "over 30 years of age testing over a 24-hour period." Numerous on-site inspections were then carried out during construction. All these measures resulted in the facade achieving an air permeability of 3.7m^3/hr.m^2 – not a bad airtightness level for a building with so much glass.

What's interesting is that the U-value of the overall facade isn't particularly stellar at 1.3 W/m^{2}K. "It was almost like a cost-optimal exercise — to bump up the facade's thermal performance you could be getting into triple glazing, really chunky frames, and how does that impact on the cost, versus getting, say, a more efficient chiller," Pat Kirwan explains. "Yet we were able to get a very good energy rating even though we didn't bump up the facade's U-values; what we did was work that hand-in-hand with the overall energy management of the system — the mechan-

> A laptop can consume up to 80% less electricity than a desktop computer, a not-insignificant energy reduction given there are 1,450 staff in the building.

Photography: Hufton & Crow

ical systems, the electrical systems and how that all fed back."

'HIGHLY INTELLIGENT' HEATING, COOLING & VENTILATION

The complex heating, cooling and ventilation systems are monitored and controlled via a highly intelligent building management system (BMS). A gas-fired combined heat and power unit provides all of the building's space heating and hot water during the summer season, supplemented by a series of 105%-efficient gas condensing boilers during the peak demand of winter season. For space heating, hot water is fed through fan coil units, and air that is initially pre-heated via a rotary heat exchanger on the building's air extract unit is then is passed over the coils to warm it further.

A chiller on the building's roof provides mechanical cooling, availing of 'free cooling' when possible. "When the external temperature falls below a certain point, it's naturally cooling down the liquid in the chiller's coils, without any energy being used to run its compressor," Pat Kirwan explains. The coils then cool incoming fresh air that passes over them. However, when external conditions fall outside those required for free cooling, the chiller's mechanical refrigeration element kicks in. Coincidentally, the building's cooling loads are also reduced by the fact that the staff use laptops instead of desktop computers — laptops give off less heat, which means less heat gains to negate.

Interestingly, the original Anglo Irish Bank HQ design was for a chilled beam strategy supplemented by boreholes with geothermal collectors that could be connected to a heat pump. But the skeleton's existing boreholes weren't integrated into the new head office's heating and cooling systems. According to Kirwan, by the time the Central Bank had bought the skeleton, fan coil technology had improved significantly and energy modelling revealed that it would be more cost-efficient to use fan coil units instead of trying to integrate the boreholes. There is also provision in the building to connect to the future line from the docklands district heating network, which will be powered by the incinerator at Poolbeg.

However, in low energy buildings such as this, it is important to focus not just on energy efficiency and airtightness, but also on an effective ventilation strategy, which is crucial for good indoor air quality. The building has a mixed-mode ventilation system which was tested via extensive energy modelling in BIM. When external conditions are favourable, the building management system opens the louvres in the building's

Explained:

Breeam (BRE Environmental Assessment Method) is an environmental assessment method for buildings that covers categories including energy, water, health and wellbeing, pollution, transport, materials, waste, ecology, and management processes. Buildings are rated on a scale of Pass, Good, Very Good, Excellent or Outstanding.

> "The building's outer skin, meanwhile, consists of a glass facade wrapped with a layer of anodized aluminium triangular mesh panels.

facade system to let in fresh air.

This cooler air is pulled through the floorplate and into the atrium via the stack effect, supplemented when necessary by a series of mechanical fans at the top of the atrium. The indoor air quality is also improved by the stringent selection of materials with a low volatile organic compound (VOC) content for the interior fit out. The indoor air quality is tracked by CO_2 monitors throughout the building linked to the BMS, which is programmed to alert when CO_2 levels reach 900 parts per million, and the supply of fresh air into the building is then increased to counter this.

The building also allows its occupants some local control; if someone sitting near an open ventilator feels cold, he or she can press a button to shut it down, and the ventilator will automatically open again after a programmed amount of time. There's also a temperature controller in each meeting room that controls the volume of incoming cool air, but the temperature range has intentionally been kept very narrow. Ingeniously, to avoid the ventilator being left on after the meeting ends, a PIR motion sensor was placed on each ventilator, so that after the meeting room is unoccupied for a programmed period of time, the PIR will shut down the ventilator.

Similar local control features can be seen in the building's LED lighting system. The lights in open plan office areas are fitted with photocells, and when natural light levels fall below a programmed LUX level, the photocell switches on the light. Staff can manually turn on separate task lights, which are fitted with a PIR motion detector that turns off the light after a given time of inactivity.

Every piece of timber that came on site had to be Forest Stewardship Council certified and accompanied by a full chain of custody certs. The project also benefited from the fact that the structure inherited from Anglo contains Ecocem (GGBS) - 50% in the superstructure and 66-80% in the foundations. However, Pat Kirwan explains that this couldn't be included in the Breeam calculation, as the standard used "doesn't consider the existing structural frame." Moreover, while Breeam awards points for use of building materials with environmental product declarations (EPDs), which include a figure for a given product's embodied carbon, among a long list of other parameters – Breeam doesn't use the data to attempt to quantify, say, the embodied CO_2 emissions of the building. Given the building's substantial concrete structure is heavy on the GGBS – a recycled material that can reduce embodied CO_2 emissions of cement by up to 90% - a feature that is likely to be one of the building's strongest quantifiable environmental benefits remains unknown.

The bank also encourages sustainable modes of transport - onsite car parking is minimised, and over 300 bike stands are provided, as well as shower facilities and lockers for runners and cyclists.

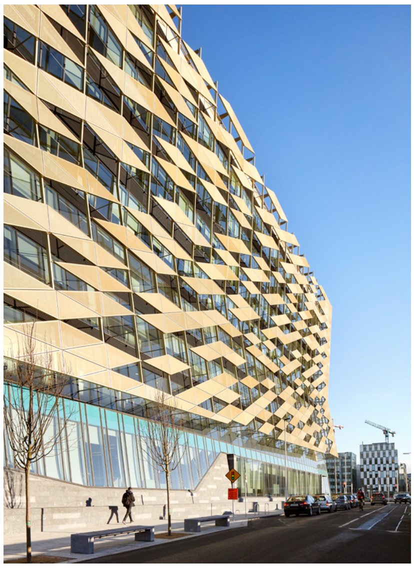
REAL-WORLD PERFORMANCE

The building's primary energy demand is calculated to be 90kWh/m^2/yr, 72% less than the original C2-rated Anglo design. But this doesn't necessarily mean that this was its performance since the building opened in March 2017, as there is always a bedding-in period with such complex buildings and also, importantly, there can be a performance gap between the expected and actual energy use. In large and complicated non-domestic buildings, the performance gap can be enormous.

Passive House Plus was unable to establish the extent and frequency of any temperature or indoor air quality fluctuations within the building, or how quickly the building responds to spikes in CO_2 levels in given areas to maintain indoor air quality. It is noticeably a little warmer on the top floor of the atrium, due to the atrium's glazed roof and the building's stack effect ventilation strategy that encourages warm air to rise to the top of the atrium. But the building appears to have relatively good indoor air quality. Data presented on CO_2 levels recorded at 4.30pm one weekday in November – at the time information was being first collated for this article - indicated that an average level of 810ppm was being maintained across all its occupied floors.

The building does seem to be performing well according to its staff. One staff member is "very satisfied with our new premises" while another praises its accessibility, stating: "the building's accessibility features seamlessly integrate with the common infrastructure.. [which] enables me to independently access all of the building's functions and facilities without having to even consider accessibility or usability challenges; this to me is the greatest gauge of an environment's success in terms of inclusive design." Liam McMunn adds: "It's palpable the lift in staff morale and how they engage with the building and their workplace."

The brief promised a revolutionary, highly-accessible working environment, that actively encourages collaboration and pushes the boundary in terms of sustainability, and from initial anecdotal feedback, it seems that the resulting building is living up to these promises. However, energy was also a key driver in the brief, and whether the building fully fulfils its highly-ambitious and admirable energy performance promises, only time will tell.

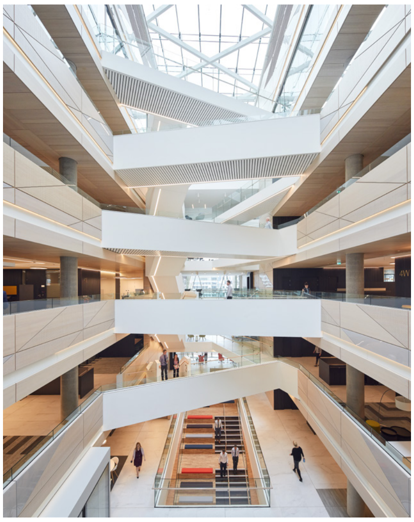


CONSTRUCTION IN PROGRESS

1-3 Progress shots showing installation of a new façade, consisting of glass skin shielded by an outer layer of anodized aluminium triangular mesh panels, on the concrete from the stalled Anglo Irish Bank HQ, on Dublin's North Quay.

SELECTED PROJECT DETAILS

Client: Central Bank of Ireland
Architect: Henry J Lyons Architects
Main contractor: Walls Construction Ltd.
Project managers: Cogent Associates
QS & civil, structural & facade engineers: AECOM
Environmental & sustainability engineers: O'Connor Sutton Cronin
Glazing: Allspec Glass & Glazing
Concrete: Leinster Reinforcements
CHP system: Temp Technology
Underfloor heating: Unipipe
Rainwater harvesting: Waterways Environmental
Joinery & interiors: Woodfit
Mechanical & electrical services contractor: Winthrop engineering & contracting
Fire engineering: Maurice Johnson & Partners
Trench heaters: Advanced Technical Products
Air conditioning: Crossflow Air Conditioning
Air handling units: Flakt Woods (Ireland) Ltd
Electric car charging: Electro Automation
Radiators: Merriott
Condensing boilers: Euro Gas
Landscape architects: Mitchell & Associates
GGBS: Ecocem
Carpets: Interface



IN DETAIL

Building type:
37,000 sqm public office building

Location: North Wall Quay, Dublin 1

Completion date: March 2017

Budget: €140m

Environmental accreditation:
Breeam Outstanding

Other accreditations: RIAI Award for Accessible Design, and ISO 5014 and OHSAS 18001 integrated certification.

Space heating demand (calculated):
45 kWh/m^2/yr

Cooling demand (calculated): 21 kWh/m^2/yr

Primary energy demand (calculated):
90 kWh/m^2/yr

Building Energy Rating: A2

Energy performance coefficient (EPC):
0.28

Carbon performance coefficient (CPC):
0.26

Airtightness (at 50 Pascals): 3.7m^3/hr/m^2

Thermal Bridging: All key external envelope interfaces were modelled in line with ISO 10211:2007. The glazed facade underwent rigorous thermal bridging analysis and airtightness testing both prior to construction with full scale prototypes and following completion to test final airtightness figures.

Glazed faced: Glass skin which is shielded from glare and solar heat gain by an outer layer of anodized aluminium triangular mesh panels. The density and coverage of the mesh is tuned to the specific orientation of the facade it protects.
Overall U-Value 1.30 W/(m^{2}K).
G-Value Glass: 0.35

Solid walls: Overall U-Value 0.27 W/m^{2}K

Roof: Overall U-Value 0.22 W/m^{2}K

Heating: A highly efficient gas-fired combined heat and power (CHP) unit runs all year round, providing a base load (summer season) for the building's heating & hot water requirements. At peak heating demand periods (winter load) the balance of the heating load is provided through a series of gas condensing boilers (105% annual efficiency). For space heating, hot water is fed to fan coil units with tempered air circulated over to provide heating. The tempered air is pre-heated via a thermal wheel on the mechanical air extract unit. The ground floor and first floor areas in the central atrium are heated via an underfloor heating network.

Provision has been made within the building to connect to a future line from the docklands district heating network which will be supplied via the Poolbeg incinerator. Once operational, the connection would ensure that the heating system demand load at peak times would be supplemented by the district heating network.

Ventilation & indoor air quality: Mixed mode ventilation system. Opening louvres at each floor level linked to the Buildings Management System (BMS), external environmental conditions are monitored via the BMS. The cool external air is pulled across the floor plate into the rising atrium via the "stack effect" and a series of mechanical extract fans located at the top of the atrium. Each bank of facade louvres are fitted with local controls. They can be locally closed or opened if required while also being linked to the BMS.

Mechanical cooling is provided by a high efficiency chiller, the chiller incorporates a free cooling module. Once the ambient external temperature reaches below a certain point, the chiller uses the external air temperature to cool down the fresh air intake to the required levels to provide a comfortable indoor working environment thus reducing the need for mechanical refrigeration.

The quality of the indoor air is monitored via CO_2 sensors, these are linked back to the buildings BMS. In order to achieve optimum levels of indoor air quality, offices typically require fresh air supply at 10L/s, this represents a level of 800ppm – 1000ppm. The BMS is programmed to alert when the CO_2 levels reach 900ppm, the supply fresh air levels are adjusted via variable air volume controllers on the supply intake to counter rising CO_2 levels. CO_2 levels recorded at 4.30pm on Wed 15 Nov indicated that an average level of 810ppm was being maintained across all occupied floors.

Lighting: All internal lighting is LED. Open plan office areas are fitted with photocells, once the natural light levels fall below a given lux level then the photocell will switch on the LED lighting. Task lighting is provided to given user control over local lighting levels, all task lights are fitted with PIR motion detectors.

Other eco-friendly measures: 300 bicycle spaces with shower and changing facilities, electrical vehicle charging points and carpooling spaces, LED lighting technology throughout, an extensive green roof was used throughout the external podium promoting biodiversity. Selection of fit out materials based on their VOC content, floor covering, and adhesive, paint, and timber engineered flooring with low VOC content were chosen. Products also included high recycled content where possible (Interface carpet with a total recycled content of 62%). All timber used throughout both the construction and fit out was FSC certified and was required to be backed up with a full suite of chain of custody certificates. ■

€10 per year

Estimated heating costs, based on combination of metered electricity use & Deap calculations

Building type: 105 sqm block-built house with external insulation

Location: Donnycarney, Dublin 9

Budget: €175,000

Standard: A1 (indicative BER), and nearly zero energy building

WANT TO KNOW MORE?

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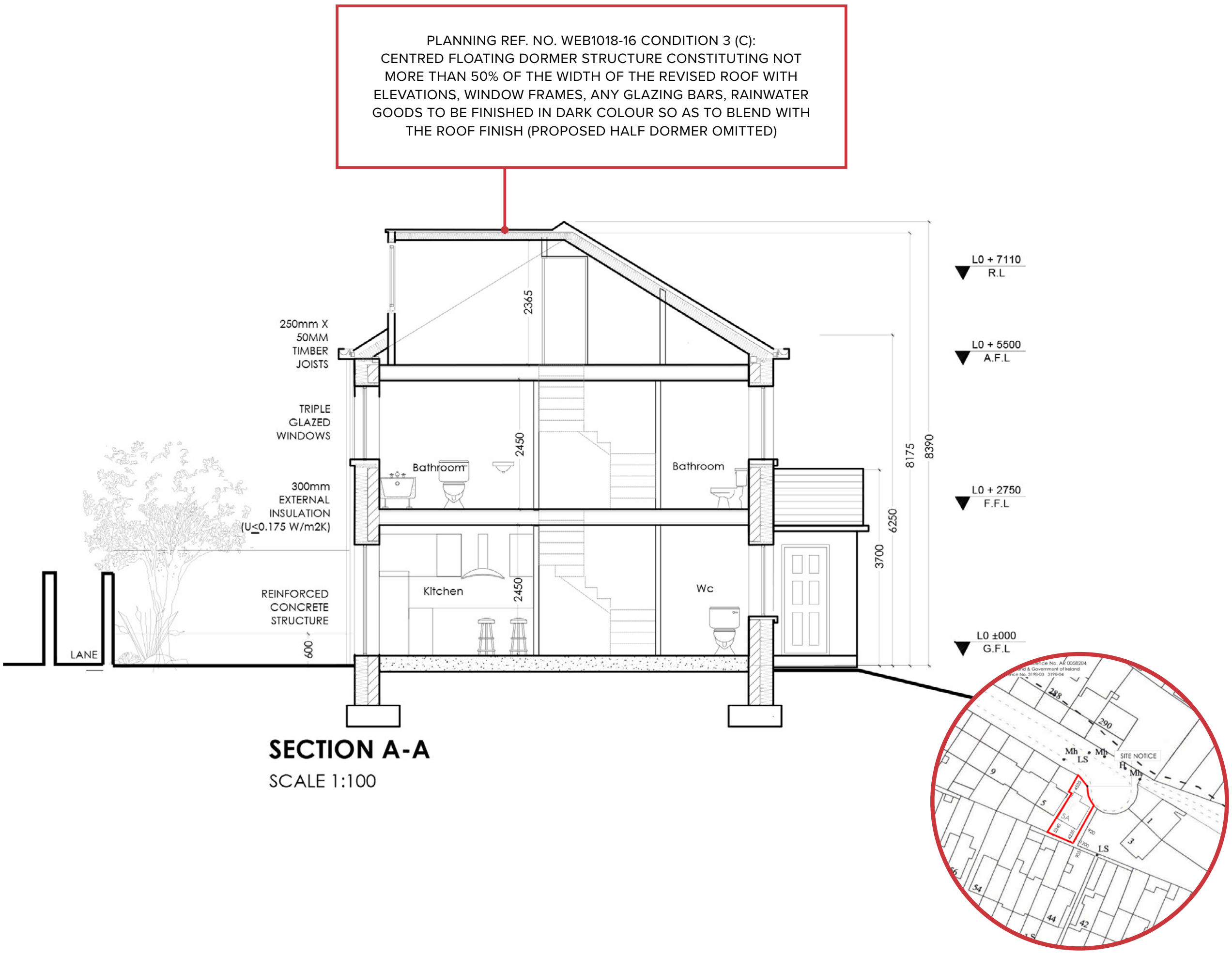
ARCHITECT RETURNS TO ROOTS WITH

A1-RATED 'HOUSE OF THE PEOPLE'

Architect Tom Duffy has long had an interest in green design, and working on a self-build project for himself and his wife he was able to prove a point: making a modest family home to the highest standards need not cost the earth.

Words by Jason Walsh | Additional Reporting by Jeff Colley



SECTION A-A
SCALE 1:100

Photography: Paul Tierney

Designing and building a massive temple to modernism with an emphasis on reduced energy consumption is more common than ever, and, the question of big expanses of glass notwithstanding, it is possible to build dream homes that meet the passive house standard. There is only one problem with the idea: though available to some, for most such homes remain a fantasy.

Not only do most people not live in white cube contemporary dream homes, such homes are unrepresentative of how the majority choose to live—even if many of us dream about it from time to time.

When it came to building his own home, architect Tom Duffy of Dublin-based Green Design Build took another road entirely: he came home.

Duffy's new home in Donnycarney is not only located on the very street he grew up on, it is a modern house that looks very much like a traditional Irish dwelling but also meets exacting standards of energy efficiency.

Moving to this house, built in the garden of an existing dwelling, was Duffy's first experience of building a house for himself, so making the most of his philosophy of green building was essential.

"We were up the road in Whitehall, and the house there was just as we bought it. When we built the [new] house, it was something we always wanted to do, especially from the point-of-view of comfort, energy [use] and running costs," he says.

"It was mostly to do with common problems like draughts and cold. The quality of construction [in Ireland] over the years has left a lot to be desired. The build structure and fabric of the house, combined with gas boilers, meant designers and builders could get away with quite poor work. Then, the warmer we make these homes the more people have problems with condensation."

Determined to avoid these problems, the design for Duffy's new home — which featured two bedrooms, with a potential extra room in the attic and the ability to convert part of the ground floor into a fourth bedroom — considered the future in terms both of energy and occupancy.

"The ground floor is designed so that the front room can be used as a bedroom. The ground floor bathroom has a shower, also. It's all about future-proofing homes and taking into account people's needs.

"We wanted to achieve a high level of airtightness and also ventilation, to achieve as close to [the passive house standard] as possible. We achieved passive in the end for airtightness and [in terms of] the levels of insulation used." The house also manages to easily beat Ireland's proposed standard for nearly zero energy buildings (nZEBs) — which is set to come into force for all new dwellings from 2021. And though it has an A2 building energy rating, the addition of one more solar PV panel would bump it to an A1.

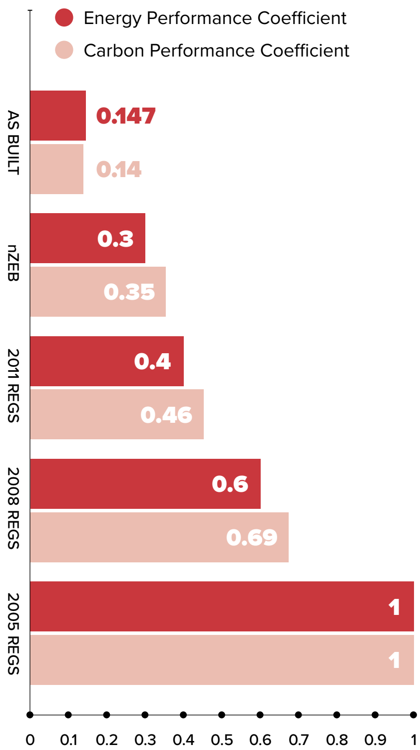
Duffy continues: "We went for mechanical heat recovery ventilation. It's a reasonably straightforward system, taking all of the air from the house, running it through a heat recovery unit and, equally, bringing in fresh air and pre-heating it," he says.

For Duffy, recent years have seen a change in clients' attitudes to energy use that he hopes will spread out to the industry as a whole, and which he attempted to encapsulate in his own home.

"It's becoming more common, thanks to publications like Passive House Plus. People are becoming more aware of the simple technologies that are available out there. They're not as exotic as they once were," he says.

Insulation is provided by a KABE Therm

> It's a common house of the common people.



external insulation system with 300mm expanded polystyrene, finished with a wet dash in order to mimic the other, older houses in the street. “It allowed us to ensure that there are no gaps and allows you to avoid cold bridging at the corners of the building. It's taken right down to the foundations, as well.”

A 4.2m x 2.1m glass sliding door provides passive solar heating. “It's triple glazed, and facing south,” says Duffy. The house also features a Daikin air-to-water heat pump providing heat to the 180 litre hot water tank, and an underfloor heating system on the ground floor, along with radiators upstairs that have, thus far, never been used.

Solar photovoltaic panels on the roof feed into the electricity, and were a straightforward choice. “Solar PV is becoming cheaper and cheaper—and taking off faster and faster,” he said.

Despite a light and airy contemporary interior, some aesthetes may wonder at the house: why not go all out on the modern feel, with a striking exterior? Duffy says that having a house that is flexible and efficient, yet looks relatively modest, is precisely the point.

“It's not designed to be flash. It sits there and minds its own business. It's a common house of the common people,” he says.

▶

ENERGY PERFORMANCE IN DETAIL

An indicative BER done for this article by Dara Stewart of leading energy consultants IHER, who had also done Deap calculations at design stage, showed that as things stand the house is coming in at a high A2 BER score of 28.45 kWh/m²/yr, whereas Tom Duffy wants an A1. Stewart calculated that adding a single PV panel to the installed 5 panel array would pull the building up to an A1, and Duffy now plans to install the panel prior to obtaining a final BER and the rare honour of an A1 rating. That said, for this building there are other routes to A1 that don't involve making any such changes. While changing the inputs on thermal bridging – in this case, the BER assumes the building's Y-factor is 0.08 – would have brought the building within a hair's breadth of A1, the reality is it would likely have risen to A1 within a year or two anyway. The primary energy factor – which takes account of the energy required at source – for electricity has improved from 2.7 to 2.08.

The estimated space heating costs of this house – the princely sum of €10.23c per year – are hard to comprehend. Stewart's indicative BER estimates the space heating requirement at 739 kWh/yr, or 7 kWh/m²/yr – a plausible figure compared to the passive house target of 15 kWh/m²/yr, given the lower comfort assumptions in Deap (more on that below). That heat is delivered by a Daikin Altherma air-to-water heat pump, with a rated efficiency for space heating of 502%, meaning the heat pump would only need to use 147 kWh of electricity per year to heat the house. As Duffy has the heat pump programmed to only come on at night time to avail of night rate electricity, the usage comes to €10 based on Energia's Cheapest Electricity night rate tariff of 6.96c. That said, irrespective of what Deap assumes, the reality is that such an efficient building may only need active heating in rare conditions – such as when ambient temperatures are low yet it's cloudy – meaning low passive solar gain and a relatively lower efficiency on the heat pump – or if the occupants return from a winter break, meaning the building has missed out on the various sorts of free gains that the building would offer when occupied – body heat, appliance use, distribution losses from the heating system, and recovered heat from showers and cooking.

But to a large extent this is splitting hairs. The building's metered electricity use of 2542 kWh/yr, when converted to primary energy and divided by the building's floor area, works out at 50 kWh/m²/yr. Although the indicative BER estimates a figure of just under half that, there's every reason to believe this building is performing in line with it's indicative A1 rating. BERs ignore unregulated energy use – the plug loads from household appliances. Those loads could very credibly be making up half of the metered energy use, even in spite of the building's solar PV array.

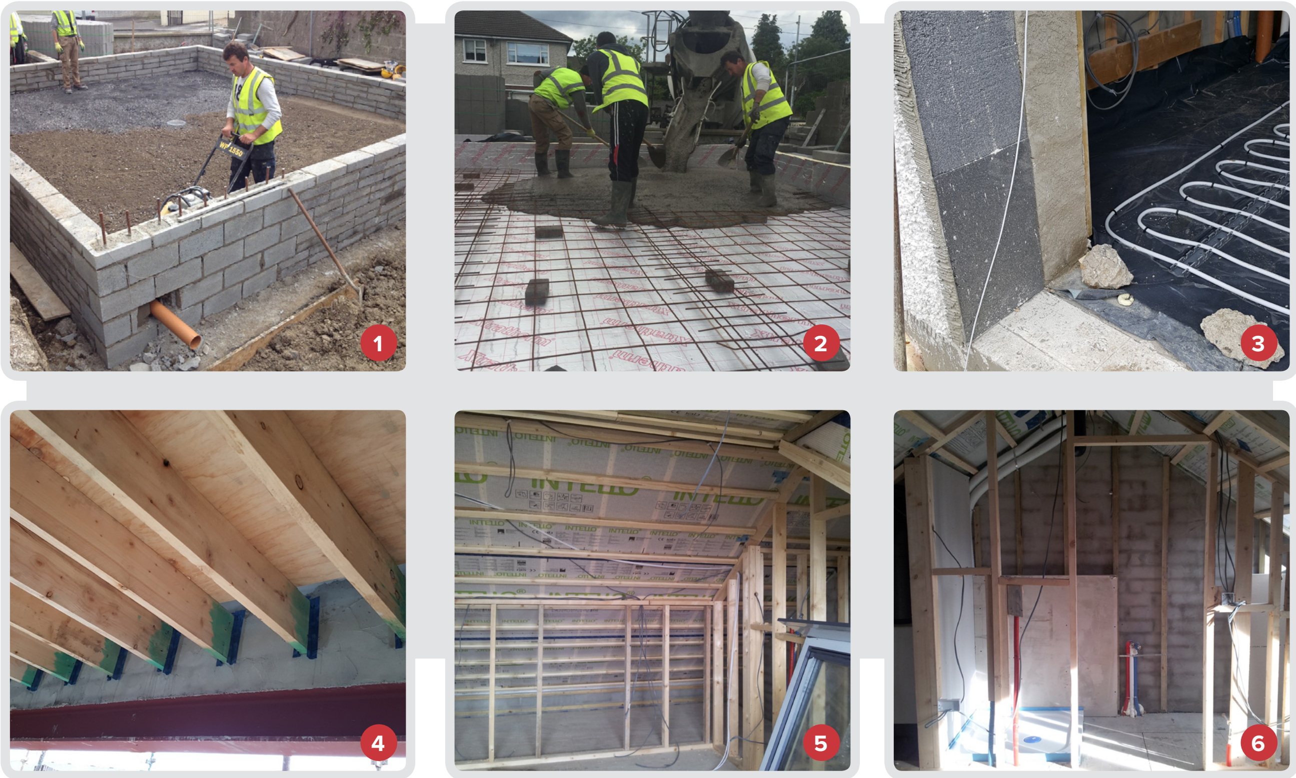
How close is this house to passive? While this house has the sort of build spec and, it appears, performance of a passive house in terms of measured energy use to date, it has been assessed with Ireland's national energy performance calculation methodology, Deap, rather than the passive house design software, PHPP. The two tools have certain key differences. For instance they make different assumptions about thermal comfort levels, and this profoundly effects the assumptions about space heating demand. While PHPP assumes buildings are heated to a minimum of 20C throughout the whole house, 24/7, Deap assumes temperatures of 21C in the living area and 18C in the remainder of the house, working out at a whole house average in this case of 18.88C. What's more it only assumes these temperatures are being met for eight hours per day throughout the heating system. (The UK's Sap tool assumes the same 21/18C split, but for nine hours per day from Monday to Friday, and 16 hours per day at weekends – meaning a total of 56 hours per week in Ireland and 77 hours per week in the UK. All other things being equal, this means the same house would have a 35% higher assumed space heating demand in the UK than in Ireland.)

PHPP also quantifies maximum temperatures reached, enabling the passive house standard to set mandatory targets to prevent overheating, an often ignored yet significant risk that must be addressed in the design of low energy buildings – especially given the increased likelihood of extreme summer temperatures in the lifespan of new buildings. In this case, Duffy reports that internal temperatures haven't exceeded 23C in the first year's occupancy.

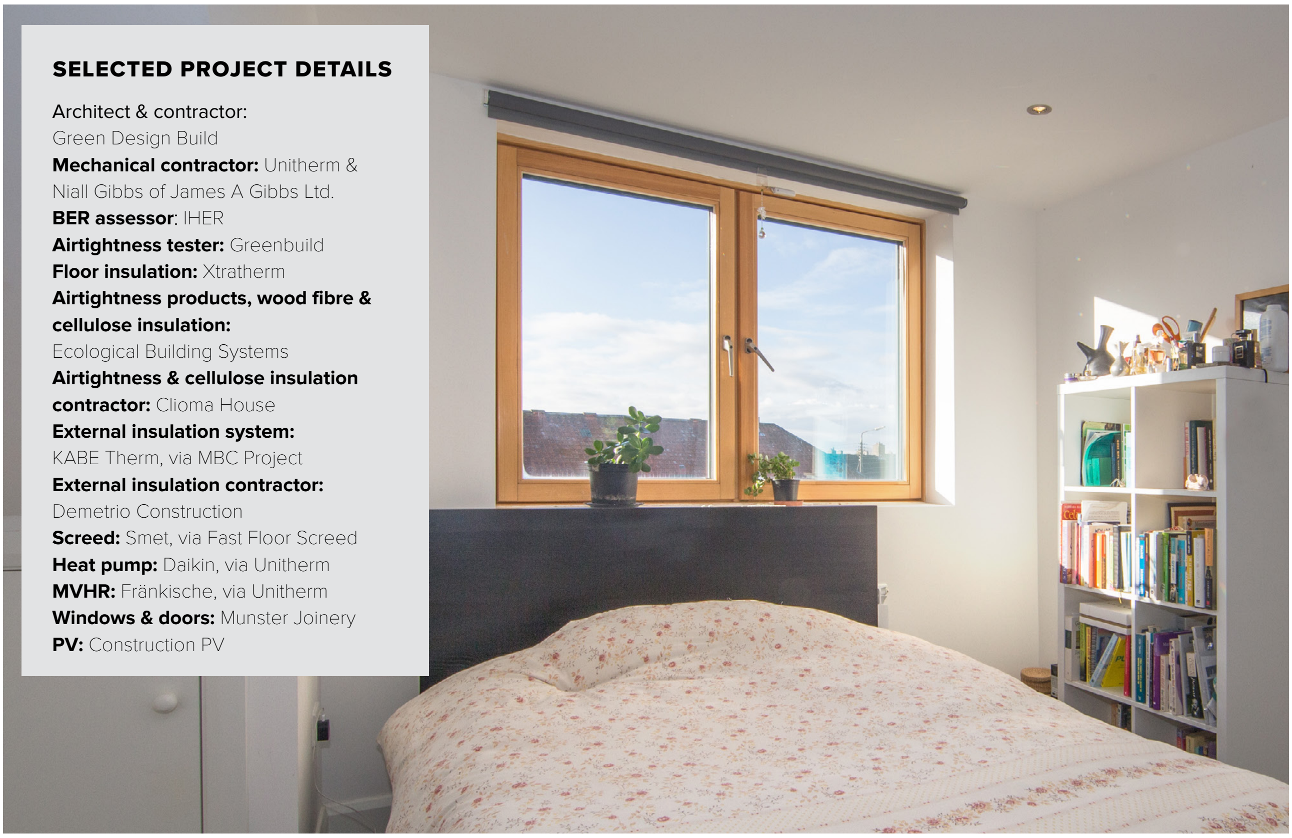
CONSTRUCTION IN PROGRESS

1-3 The block walls of the house were externally insulated with 300mm KABE Therm platinum expanded polystyrene insulation, right down to the foundations, which prevents cold bridging at ground level. The walls were then finished with a wet dash in order to mimic the other, older houses on the street.

CONSTRUCTION IN PROGRESS



1 As work progresses on the foundations, a plate compactor is used to ensure a solid, stable base for the concrete slab; **2** pouring the concrete slab; **3** a cross-section of the wall build-up showing wet dash finish followed inside by external insulation, 215mm solid block walls, sand-cement plaster and insulated plasterboard internally; **4** airtightness detailing around joist ends; **5** pro clima Intello airtightness system under counter battens to create a service void while minimising airtight layer damage by service penetrations; **6** a parge coat serves as the airtight layer on the inner face of the single leaf block walls.



SELECTED PROJECT DETAILS

Architect & contractor:
Green Design Build
Mechanical contractor: Unitherm & Niall Gibbs of James A Gibbs Ltd.
BER assessor: IHER
Airtightness tester: Greenbuild
Floor insulation: Xtratherm
Airtightness products, wood fibre & cellulose insulation:
Ecological Building Systems
Airtightness & cellulose insulation contractor: Clioma House
External insulation system:
KABE Therm, via MBC Project
External insulation contractor:
Demetrio Construction
Screed: Smet, via Fast Floor Screed
Heat pump: Daikin, via Unitherm
MVHR: Fränkische, via Unitherm
Windows & doors: Munster Joinery
PV: Construction PV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Explained:

Nearly zero energy building (nZEB): From the end of 2018 all new public buildings in EU countries must be nZEBs, while the same rule will apply to ALL buildings from the end of 2020. Each country is free to come up with its own definition of an nZEB, within certain parameters.

Ireland is proposing that for dwellings, nZEBs must have an energy performance co-efficient (EPC) of 0.3 or less in the Deap software, which is used to calculate building energy ratings and demonstrate compliance with Part L of the building regulations (which deals with energy consumption).

Because Deap uses Ireland's 2005 version of Part L as a reference, this means that a house with an EPC of 0.3 uses, in theory, 30% of the energy of a house built to the 2005 regulations.

IN DETAIL

Building type: Detached 105 sqm solid concrete block house with external insulation

Location:
Collins Park, Donnycarney, Dublin 9

Completion date: November 2016

Budget: €175,000

Passive house certification: N/A

Space heating demand (DEAP):
7 kWh/m²/yr

Living area fraction: 29.17%

Measured primary energy demand:
50.47 kWh/m²/yr (Dec 2016 – Dec 2017)

Energy performance coefficient (EPC):
0.147

Carbon performance coefficient (CPC):
0.140

Indicative BER: A1 (24.88 kWh/m²/y) – subject to client adding one more PV panel.

Airtightness (at 50 Pascals):
0.54 ACH or 0.61 m³/m²/hr

Thermal bridging: External insulation which extends into foundations, thermally broken windows sat in insulation layer. Y-value of 0.08 used based on ACDs, though the actual value, if Psi-values had been calculated, would be substantially better.

Heating costs: €10 per year (see panel on page 51 for details).

Total energy bills: €610 per year based on metered annual usage of 2,542 kWh (Dec 2016 - Dec 2017), including 1,663 kWh day rate and 878 kWh night rate. Including all energy use, taxes, standing charges and PSO levy), assuming Energia's Cheapest Electricity tariff.

Ground floor: 75mm Südanit 280 alpha hemihydrate screed, on 150mm Xtratherm, on 150mm concrete slab, on 100mm Xtratherm perimeter insulation, on 150mm Xtratherm insulation. Insulation extends to foundations on both sides of the rising walls.
U-value: 0.07 W/m²K

Walls: 300mm KABE Therm external insulation system consisting of rough cast finish on 300mm platinum EPS insulation, on 215mm solid block walls, on sand/cement plaster for airtightness with tapes at junctions, on service cavity, on 62mm insulated plasterboard.
U-value: 0.08 W/m²K

Roof: Concrete roof tiles on battens, on 60mm Gutex wood fibre insulation, on 265mm cellulose between rafters, pro clima Intello membrane, 62mm insulated plasterboard on counterbatten.
U-value: 0.10-0.11 w/m²K

Windows: Passive House Institute-certified Munster Joinery Passiv Aluclad thermally broken triple glazed windows and doors.
Overall U-value: 0.71 W/m²K

Roof windows: 1 x Velux double glazed roof window to ensuite bathroom.
Overall U-value: 1.4 W/m²K

Heating system: 4kW Daikin Altherma split air-to-water heat pump – 503% efficiency space heating and 213% efficiency for domestic hot water – supplying underfloor heating and 180 litre h/w tank, & radiators (not used).

Ventilation: Fränkische Profi Air 250 mechanical ventilation with heat recovery (MVHR) system – rated at 88% efficiency in this house.

Electricity: 5 x 275W Trina monocrystalline solar PV panels, with a further panel to be added.

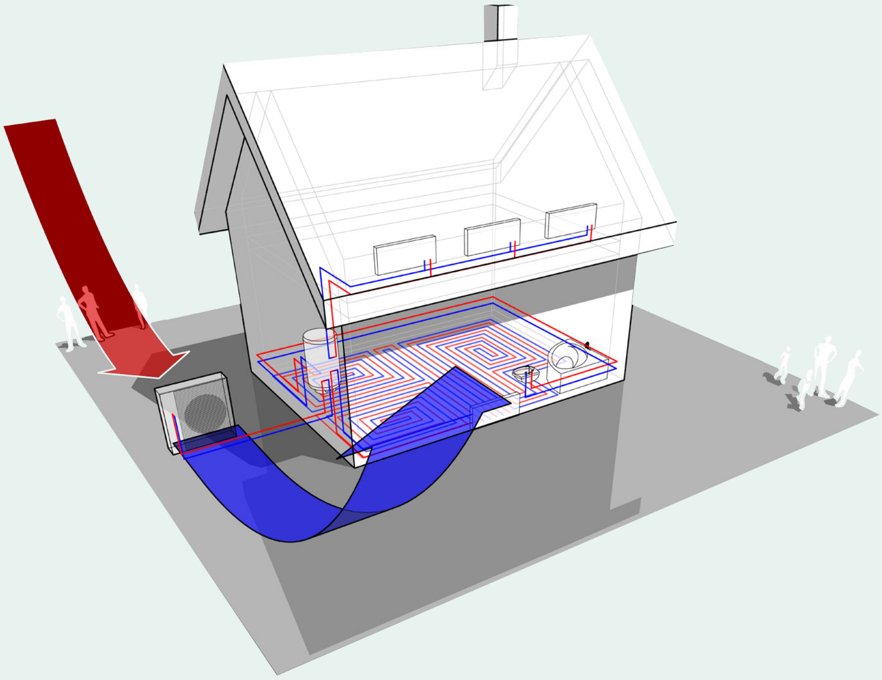
Green materials: Cellulose insulation, Gutex wood fibre insulation.

■

The PH+ guide to
AIR SOURCE HEAT PUMPS

As electricity supply from renewable sources continues to grow, and electricity grids gradually decarbonise as dirtier fossil fuels are phased out, heating homes with electrical technologies like heat pumps starts to make more sense. And in the mild, temperate climate of Britain and Ireland, air source heat pumps are particularly suitable — especially as new build standards of energy efficiency continue to tighten, meaning new homes need less and less energy to achieve comfortable indoor temperatures. But how do air source heat pumps work, what types are there, and how much do they cost to run? Our in-depth guide attempts to answer the key questions.

Words by John Cradden & Jeff Colley



The electrification of heat maybe something of a slow-burning revolution, but it's clear that air source heat pumps (ASHPs) will have a big role to play in any mass switch away from fossil-fuel burning heating technologies to renewable ones.

Besides being a very popular choice of heating input in many passive houses and – thanks to Irish building regulations which require both renewable energy technologies and primary energy savings – in Irish new homes, ASHPs are catching on in deep retrofit schemes. With generous subsidies available for ASHPs and other renewable energy systems in the UK through the Renewable Heat Incentive, and the Irish government's recently announced €3,500 heat pump grants for Irish homes built before 2006, as well as up to 30% of the cost of heat pumps in non-domestic buildings.

But the potential for ASHPs to be used in new build in general is also high, as they can clearly help to meet stringent efficiency and renewable energy targets, including the nZEB requirements that all EU member states – and subject to the Brexit negotiations, the UK – are bound to implement imminently for dwellings and non-domestic buildings.

Advocates insist that the relatively mild climate in the UK and Ireland means that ASHPs are almost as efficient as ground source heat pumps, not to mention cheaper and simpler to install, making it one of the most popular heating system choices for new builds and also for retrofits. Furthermore, a variety of technology upgrades have been introduced over the last few years.

How do they work?

A heat pump is similar to a fridge in the way it works, in that the heat is taken away from the storage section of the fridge and released at the rear. In a heat pump the process is the opposite way round – the heat is taken from the air, ground and water and released into the building.

Any pump needs electricity to run, but it should use far less electrical energy than the heat it produces.

While a ground source heat pump uses the heat energy in the ground – either via horizon-

tally laid or vertical borehole collectors – as a heat source, and a water source heat pump will extract it from water, an ASHP uses the outside air.

Air temperatures vary seasonally and moisture content fluctuates also, so an air source heat pump will always be at the mercy of the climate. The colder the air temperature, the harder the heat pump must work to lift the temperature up to what is required for heating. What also affects its efficiency when compared with other types of heat pump is the propensity for frost to gather on the collector in colder temperatures. Most ASHPs will have a 'defrost' mode to prevent this, but that means it uses more electricity. More on this later.

Exhaust air heat pumps such as the NIBE F730 feature no outdoor unit.

Types

The most common type of ASHP used in dwellings is an air-to-water heat pump, where the refrigerant gas transfers the energy harvested from the air through a heat exchanger, which heats water for heat distribution via underfloor heating or radiators along with domestic hot water.

While ASHPs typically take external air as their energy source, one type of ASHP – an exhaust air heat pump – collects energy from warm inside air as it leaves the building via the ventilation system and reuses it for space heating and/or hot water. They are mostly suited to small, highly energy-efficient or passive houses with good ventilation systems. There are also hot water heat pumps, which can run on 70% less electricity than immersion heaters when used in tandem with a hot water storage tank. Air-to-air heat pumps use the ventilation system to distribute the heat but as the name suggests can't heat the hot water.

Difference between CoPs and SPFs

The two most widely used values for gauging the efficiency of a heat pump are the Co-efficient of Performance (CoP) and Seasonal Performance Factor (SPF).

The CoP is a simple ratio of the heating provided by a heat pump to the electricity consumed. So a CoP of 3 means that the pump will convert 1kW of electricity into 3kW of heat. Given that the warmer the external heat source, the less electricity it needs to get the heat up to a reasonable temperature, this means that the CoP will vary throughout the year. So the CoP would be lower in the winter months than the summer.

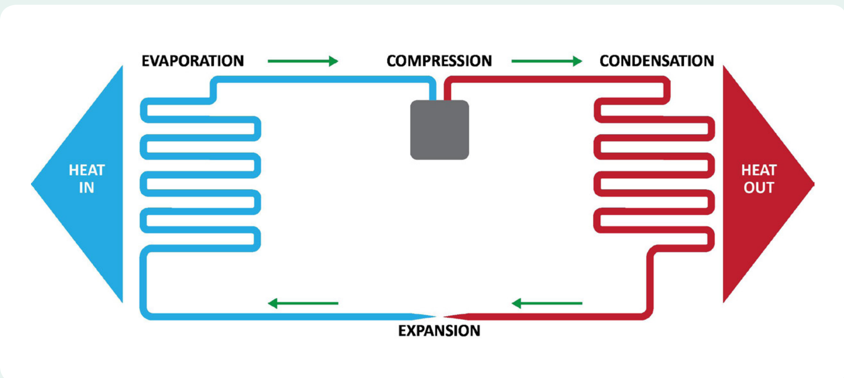
The seasonal performance factor (SPF), however, takes into account how well the heat pump works at both low and high temperatures, while also taking into account additional energy use such as circulation pumps, electric immersion, etc. It is measured as the ratio of the heat delivered to the total electrical energy supplied over the course of a full year, and so is said to be a more accurate measurement of a heat pump's performance in real world conditions.

Operation and lifespan

Anyone new to heat pumps will need to be educated in how to use them. A typical fossil fuel boiler tends to be cycled on and off, blasting heat at high temperatures into radiators intermittently. The optimum way to operate a heat pump is to keep them ticking over at low temperatures for long periods. Counter-intuitively, it's a question of leaving the heating on to save energy.

"Yes, people can be puzzled," says British heat pump consultant John Cantor. "Believe it or not, I had a heating engineer in our cottage who was puzzled. He said the rads are always lukewarm but the cottage is hot. He had not realised that long run hours will bring results. People are rarely patient; slow-response heating is not intuitive when people don't have a feel for the heat capacity of things."

If users do end up operating them like boilers, this affects the lifespan of a compressor. A compressor that has a longer run time profile can last around 15 to 20 years compared to a frequently cycled compressor



An illustration showing the science of how heat pumps work.

Excluding exhaust air heat pumps, air-to-water heat pumps feature both an indoor and outdoor unit.

which may need replacing after just six years. A boiler can be cycled on and off without limiting the lifespan of the system. Options to ensure greater longevity can include specifying models with variable outputs, along with buffer tanks.

Design and sizing is also critical to the lifespan of an ASHP. The size of heat pump should be aligned as closely as possible to a house's design heat loss, ideally allowing a little spare capacity. But selecting a heat pump that is too big (and many experts says this happens a lot) can lead to it spending too much time trying to run at its minimum setting and prompting more frequent cycling of the system rather than running at a nice steady state at mid-range for long periods.

There is some debate about the suitability of ASHPs in passive houses, with one argument being that it will only operate for space heating when it's very cold outside. This will affect the CoP, which can also be dented by the many hours it rests on standby power. But since the energy bills are still low, this issue may be overlooked. On the other hand, passive houses are designed in such a way that even in adverse conditions, a steady trickle of extremely low temperature heat may be the ideal way to heat the building.

In terms of where they should be installed, beauty is in the eye of the beholder, but ASHP outdoor units might not look too pretty hanging off a building – and planning could be required if a collector is put at the front of a building. The collectors can be sited close to the building instead, although it's important that there is enough air circulation around the outdoor unit, as obstructions potentially limit the efficiency of the heat pump. (They're exposed to ensure they catch the air.)

Monoblocs vs. split units

There's also the issue of whether to use a monobloc or a split unit. Some say that split units, where the heat transference from the refrigerant gas to water takes place inside the building while the collector remains outside, are more efficient than monoblocs, but there are some site-specific issues to consider, so either option – and even each machine – needs to be taken on its own merits.

Monoblocs are generally well suited to the Irish and UK climates; their use would only be an issue in locations that experience prolonged freezing conditions – to be confirmed by manufacturers if anti-freeze is recommended to be used (and therefore the risk of lower CoPs). Even then, as long as the pipes running inside and outside the unit are well insulated, they can be used. Besides being slightly cheaper, monoblocs are easier to install; unlike splits they don't need specialist, refrigeration technicians to do the pipe work.

Much of the case for using split units seems to depend on the layout of the house and, in the case of a retrofit, whether the whole heating system is being replaced. (For both split and monoblocs, replacing the whole heating system and pipe work should be considered in retrofit scenarios). Situating it in the centre of the house is considered best practice to minimise heat loss and water pipe runs.

Heating distribution

An ASHP will work best with underfloor heating, as it can distribute the heat over a large surface area at temperatures as low as 35C. Standard steel panel and aluminium radiators are typically set up for a flow temperature of 65C but these can also be sized for flow temperatures of 40-45C, as well as fan-assisted rads, ensuring then that higher efficiencies may be achieved. The lower the flow temperature, the higher the SPF.

Tipperary Energy Agency's SuperHomes nationwide deep retrofit scheme provides compelling evidence. Among other things, the scheme has involved upgrading homes to take ASHPs, while also improving airtightness, insulation and adding energy efficient mechanical ventilation systems – typically demand control ventilation. The heat pumps are connected to the home's existing radiators, perhaps with a few extra radiators depending on the layout of the house, and are set up to run at very low temperatures almost all the time, taking advantage of the improved heat retention as a result of other measures in the package of options available.

"In principle if we double the time the heating system is in operation, we can halve the temperature difference between the emitter and the room in comparison to an oil or gas boiler," says Tipperary Energy Agency's CEO Paul Kenny. "We also increase the duration of the heating system operation that allows the heating system operate really efficiently. Our designs allow the use of about 50 per cent of radiators."

Cooling

Some air-to-water heat pumps can be reversed to cool buildings, which may be particularly useful in office buildings (though passive cooling from bore holes may tip the balance towards geothermal heat pumps in larger buildings). It's questionable, though, as to whether cooling is a big issue with most of the housing stock amid our relatively mild climate, though heat waves are likely to become more intense and more frequent as the world warms. But without due design care, overheating can be a more serious risk in well-insulated and airtight homes – and even in poorly insulated buildings with large expanses of south-facing glazing. In most cases this can be dealt with through brise soleil or shading – and mechanical ventilation can help to shift accumulating hot air – otherwise a heat pump could be used in reverse in conjunction with underfloor heating or wall and ceiling cooling radiant panels, but it's a complex solution to a problem that could potentially be avoided, with a little design foresight.

Defrost mode

One of the factors that will directly affect the CoP or SPF of an ASHP is if frost occurs in the evaporator. In Ireland this is said to be most likely to occur when the temperatures are between 3 and 8C outside, which means they need to use a defrost mode to prevent the evaporator (collector) icing up, supposedly reducing the CoP by about 10 per cent. In most systems, the heat pump can't operate in either heating or DHW mode until the evaporator is defrosted. If the heat pump is undersized this may result in a high number of defrost cycles which reduces the efficiency of the heat pump, meaning the system underperforms.

However, according to Seamus Hoyne of Limerick Institute of Technology, which has been monitoring 20 SuperHomes since April this year as part of the SuperHomes 2.0 research project on optimising the performance of ASHPs, the energy 'drain' caused by the defrost mode has been negligible. Detailed data from November 2016 seen by Passive House Plus for one SuperHomes house in Tipperary showed that the defrost mode was used 0.4% of the time, totalling 2% of the monthly running costs. The average local temperature that month was 5.1C, with relatively low rainfall levels.

Lower cost systems offer only a rudimentary control of frost build-up, and tend to have a reduced SPF because of it, but newer systems reportedly work much better. Some machines will simply increase the fan speed in conditions when condensation is occurring to stop the collector from icing up. An emerging technology is a 'dual evaporator' that allows for defrosting whilst continuously supplying heat.

Connections to other heating sources

Aside from oil boiler companies moving into heat pumps (such as Firebird and Grant, among others) and selling them with oil boilers as a back-up that kick in during sub-zero conditions, heat pumps can be paired with existing and other energy sources. With the internet of things, some heat pumps can talk to solar PV systems, so that they come on when the PV array is generating more electricity. They can also be combined with solar thermal, biomass boilers and heat recovery ventilation systems.

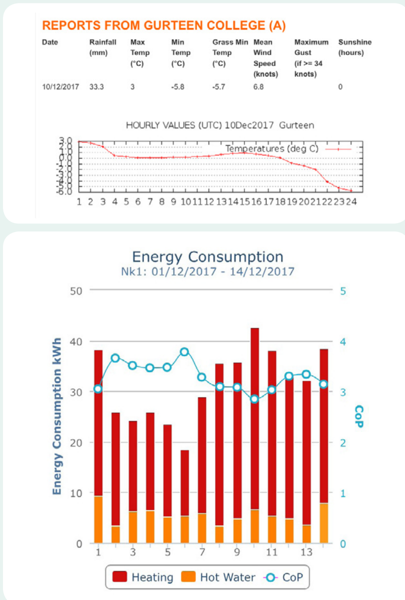
Typical capital costs.

The typical starting capital cost of a reputable ASHP (excluding the cost of the heating distribution system or installation) for a 200 sqm house would be in the region of €8,000 excluding VAT, while a scheme of 100 sqm houses might be able to get one for €5,000.

Typical running costs

Helpfully, SEAI's comparison of the energy costs of domestic fuels recently includes a section on electricity used by heat pumps. Its figures for July 2017 show that heat pumps with high SPFs are clearly the cheapest form of heating in Ireland. Heat pumps with a listed average SPF of 4, (day rate electricity band DD) cost 4.98 cent per kWh and on night rate, just 2.28 cent per kWh. An oil boiler burning kerosene at 70 per cent efficiency – as assumed in SEAI's Deap software for boilers for homes built between 1985 and 1997 – would cost 10.09 cent per kWh, making a relatively high SPF heat pump less than half the running cost of oil, even before night rate electricity is considered.

The picture's similar with natural gas: a 72% efficient gas boiler (the assumption for pre '98 boilers in Deap) would cost 11.51 cent per kilowatt in band D1 (below 5,556 kWh/yr) or 9.42 cent in band D2 (from 5,556 to 55,566 kWh/yr).



Monitored CoP data for Paul Kenny's heat pump during the cold snap in December 2017, alongside local weather data for the coldest day in that period, 10 December. The heat pump dropped just below a CoP of 3 on the coldest day.

It's also worth noting that SEAI's figures are punitive towards heat pumps, in that they build standing charges into the unit costs. The point is that those standing charges would be incurred irrespective of whether a heat pump was installed, due to the normal electrical use. Conversely this is a fair approach in the case of natural gas, as the standing charge relates directly to heating and hot water and little else. After all, if households don't have gas-based heating and hot water they're highly unlikely to maintain a gas supply for cooking, which surely wouldn't justify the standing charges on its own. And once standing charges are removed from the electricity prices, an even wider gap emerges. Based on the cheapest electricity tariff currently listed on Irish price comparison site Bonkers.ie and an SPF of 4,

the heat pump running costs drop to 3.63 cent at day rate and just 1.74 cent at night rate. The figures still look impressive at a much more modest SPF of 3: a day rate of 4.84 and night rate of 2.32 cent respectively.

But what about data on real world performance? Passive House Plus readers may recall countless examples of low energy buildings with impressively low ASHP running costs – including figures as low as €170 per annum for heating and hot water for semi-detached family homes (see panel) – though it's worth emphasizing that in the case of passive houses, most of the heavy lifting regarding space heating is done by the sheer efficiency of the buildings.

There are also promising signs emerging from the SuperHomes 2.0 project, which includes monitoring of 20 air-to-water heat pumps. Though the 77 SuperHomes retrofits done to date have included a broad range of heat pumps – CTC, Dimplex, Daikin, Hitachi, Mitsubishi, Nibe, Panasonic and Samsung – the monitoring study consisted almost entirely of Mitsubishi units, given that most other units didn't have suitable monitoring systems in place for project commencement in April 2017. Based on the data collected from April till the end of November 2017, the average seasonal CoP – for both space heating and domestic hot water – is between 3.2 and 3.5, while the average SPF – allowing for immersion use, defrost mode, etc. – is between 3.0 and 3.2. A fuller picture will appear once twelve months of data has been gathered – including winter performance – but the signs are that the average SPFs in this study will be substantially better than the average for ASHPs of 2.45 registered by the Energy Saving Trust in 2013.

Data from Paul Kenny's heat pump during the cold snap in early December provides further encouragement. Between 1 and 13 December the CoP averaged for heating and hot water only dropped a little below 3 on one day, 10 December, when temperatures dropped to nearly -6C. "From Sunday to Tuesday we had three inches of snow lying on the ground and a very hard ground frost overnight," says Kenny.

Night rate meters

Most heat pump installations reportedly run on a mix of day rate and the cheaper night rate electricity. It would certainly appear to make sense to run air-to-water heat pumps at night, even when temperatures are likely to be lower (and thus the CoP) and even if the standing charge is a bit higher. If you use night rate electricity to generate hot water at night, and to run dish washers, washing machines etc., then so much the better.

But do night rate meters go far enough? Seamus Hoyne of LIT says that as part of the research into optimising the performance of heat pumps, it is looking at the feasibility of a heat pump tariff in conjunction with Electric Ireland and ESB Networks if much of the load of heat pumps could be shifted away from peak times.

Large low maintenance nZEB house

Heat pump running costs: €170/yr

Completed in February 2015, this 389 sqm family home was built by experienced passive house contractors Mannion Passive House Builders, and features a Nibe F2040 12kW air-to-water heat pump.

Homeowners Sinead and John have been maintaining the house at a minimum of 21C, and the monitored heat pump energy use has been just 1,445 kWh per year for space heating and 2,213 kWh for hot water – meaning that if just 30% of the energy is used at night rate, the heat pump's annual combined space heating and hot water costs would be just €170 – excluding whatever additional energy use may come from the home's gas fire and wood stove. What's more the homeowners could hardly be accused of micro-managing the heat pump to optimise performance. "I don't even know it's there," Sinead told Passive House Plus. "I never have to turn it off or turn it on."

The house, which was featured in issue 21 of Passive House Plus, scored a mid A2 BER, and comfortably beat the energy and carbon targets for Ireland's forthcoming nearly zero energy building standard.

In theory, smart grid technology could be connected to intelligent controls at heat pumps so that heat pumps (and other appliances that aren't required to be on immediately at any given time) can be turned off and on depending on energy supply vs. demand. This could also help mitigate any potential issues with power outages.

Tipperary Energy Agency CEO Paul Kenny, who runs the SuperHomes scheme, has availed of a SuperHomes retrofit himself – including heat pump, PV array and a fabric upgrade – and is making good use of the night rate tariff, with 55% of his total household electricity consumption at night rate. But most people, it seems, are less likely to try and avoid the higher tariff. The indicative average, according to Hoyne, is 30 to 35% night rate to run heat pumps across the monitored homes.

Primary energy

While heat pumps are clearly greener than oil or gas boilers, their true greenness does, of course, depend on the source of the electricity generation that powers it. So the same heat pump may have very different ratings based on the electricity mix in whichever country it's installed in, and also on when it was installed. For example, in Ireland the primary energy factor for grid electricity used in Deap (and thus for BERs and Part L compliance) was 2.7 up until 2006, meaning 1kW used to power a heat pump was regarded as 2.7kW at the power station. It has fallen progressively since SEAI started updating the figure in 2010, and is now 2.08 – a 23% drop. Meanwhile, the carbon intensity figures have fallen by an even greater margin of 36.4%, from 0.643 to 0.409 kg/kWh. In the UK, similar improvements are apparent between the still current SAP 2012 software, and the proposed SAP 2016. The primary energy factor is proposed to drop from 3.069 to 2.364, with the carbon intensity dropping from 0.519 to 0.398 kg/kWh.

Given the commitments Ireland and the UK have made to increase renewable electricity generation in the short, medium and long-term, these figures are bound to keep dropping, meaning the energy and carbon figures for buildings heated by electrical sources are bound to keep improving over time.

However, while primary energy figures have been dropping, the cost per unit of delivered energy (i.e. the energy registered at the meter) in Ireland has risen by around 20% since 2010. All of which really means that in the case of working out the running costs of a heat pump, it's the amount of delivered energy required to run it that really counts – and the cost per unit of electricity (both current and projected).

Challenging assumptions on heating profiles

In some types of buildings in Ireland at least, there's evidence to suggest that space heating use may be peaking not during the coldest times of the year, but in the so-called shoulder months, a theory put forward by consulting engineer Paul Overy noted in issue 1 of Passive House Plus. Having mapped out a year's worth of weather files including hourly readings for Birr, Co Offaly, Overy found a clear correlation: once temperatures drop below 4C or so, there's a clear and progressive drop in wind speeds. The article posited a few possible contributing explanations: heat loss caused by infiltration, poor wind-tightness meaning wind whipping heat out from insulation, and occupant's turning up the thermostat due to the discomfort caused by draughts. This leads to a couple of pertinent conclusions. Airtightness and wind-tightness rise in significance, while heating demand may be peaking in ideal weather for air source heat pumps – and at the precise times when more wind energy may be available, which in turn means the real-time primary energy of electricity used by ASHPs may be better than the annualised average.

Hot water production

The typical CoP of air source heat pumps for domestic hot water (DHW) generation seems to be lower than for space heating, often struggling to get above 3, even in the summer. "My feeling is that nobody is pushing the manufacturers to improve matters here," says John Cantor.

To ensure a system has hot water on demand, how you set it will be crucial. For instance, you could set the timer so that the heat pump heats DHW only in say, two time periods a day. At the start of the day's hot water heating when the cylinder bottom is quite cold, the initial start may have a CoP of 4. This may have dropped to 2 by the time it has reached 55C, but the average would be quite good, says Cantor.

Immersion use

Most heat pumps come with inbuilt immersions, ostensibly as a back-up and used only as a last resort as long as the system is properly designed, sized and installed, according to those in the trade.

They may be used to bring the water temperature up higher for DHW in certain circumstances or to "flash" the water up to 55 or 60C say, once a week, to prevent legionella from occurring. But lots of ASHP companies say the immersion is never used. The average SPFs – which include immersion use – of 3 to 3.2 reported so far in the SuperHomes retrofit study indicate that the immersion use in well-designed systems should be negligible, meaning a potentially significant reduction on energy bills. According to Electric Ireland, the average Irish household spends about €1.30 per day - €475 per year - on electric immersion use for domestic hot water. Which? Magazine estimates the immersion use in a typical UK house to be "at least £360 a year".

One alternative to built-in immersion is a desuperheater, which is a small, auxiliary heat exchanger that uses superheated gases from the heat pump's compressor to heat water. "A desuperheater is a great add-on to a heat pump system giving a small percentage of the output at a high temperature for domestic hot water needs", says Dr Niall Burke of Athlone Institute of Technology, who did his PhD on heat pumps.

Others, however, believe that the key to minimal use of the immersion is longer or even constant use cycles at low temperatures.

Not all in-built immersions are equal, it seems. "The cruder ones can 'panic' and switch on the immersion far too eagerly. It can take a little skill to set the system up to avoid this," says Cantor.

Controls

There is some debate about whether or not heat pumps work best when there aren't too many 'zones'. Many folks prefer their bedrooms to be cooler than their living rooms, and in some passive houses, their owners have opted not to include underfloor heating in bedrooms to facilitate this. However, some say that fitting too many room thermostats can confuse a heat pump controller, leading to more cycling on and off, leading to higher running costs and reducing lifespan. A buffer tank may be needed if this is the case. ■

WITH THANKS TO

Dr Niall Burke, *Athlone Institute of Technology* | John Cantor, *heat pump consultant* | Damien Mullens, *Heat Doc* | Calin Tasnadi, *Heat Pump Association of Ireland/Daikin* | Paul Kenny, *Tipperary Energy Agency* | Seamus Hoyne, *Limerick Institute of Technology*

SuperHomes cost-optimal retrofit

Heat pump running costs: €491/yr

The home of Tipperary Energy Agency CEO Paul Kenny used to be an energy guzzler. Having upgraded and sold his previous home, Kenny and his wife Norah bought a 225 sqm house in Newtown, Co Tipperary, to accommodate their growing family, but were braced for the worst. "The previous tenant had moved out as the house was too cold," says Kenny. "She said she used four tanks of oil and a bag of coal a week and it was still freezing!" Kenny duly had the home's cavity walls pumped with insulation before moving in, but it wasn't enough: "The day we got the keys storm Darwin hit and the house leaked so much the curtains shook." Kenny spent the following spring sealing the window frames.

Pre upgrade, the BER for the 2005 home was a B3, with a total calculated primary energy use of 129 kWh/m^2/yr. Heated by home heating oil, the house cost the family €2,228 to heat in 2014 in spite of Kenny's cavity insulation and window sealing, between running the oil boiler and wood fuel. As is so often the case with such buildings, that was in spite of the home being uncomfortably cold at times.

Kenny, who set up the SuperHomes scheme at TEA, availed of a SuperHomes retrofit himself – including a Mitsubishi air-to-water heat pump, PV array, Aereco demand controlled ventilation and a fabric upgrade at a total cost of €19,500, or €12,650 after the grant. The project was an early test of the SuperHomes approach of well-considered, cost-effective measures: insulate, remove draughts and ventilate intelligently to ensure good indoor air quality while reducing ventilation heat loss, to create the conditions where a heat pump could be attached to the existing rads – with some additional rads if necessary – and run for long stretches at low flow temperatures.

The reported results are impressive: Kenny's heat pump clocked a combined total of 4,739 kWh for space heating and hot water in 2017. Assuming the current lowest electricity price from price comparison site Bonkers.ie that adds up to €491, along with an estimated €75 worth of wood fuel.

Other than the efficiency of the building, the heat pump is aided by Kenny's PV array, which produces 1,700 kWh of electricity – 100 kWh of which is exported to the grid for nothing, given the lack of micro generation incentives in Ireland. Kenny has measured that 460 kWh is dumped into the immersion, displacing a little night rate electricity, while Kenny estimates that the remaining 1,140 kWh is split roughly 50/50 between household electricity use and powering the heat pump, worth €82 in each case.

But this undersells the benefit. The house is now running at a consistent 20+C, which is very different to the under-heated house he had before. He has calculated that attempting to heat the original building to the same comfort level – and in reality this would have caused the building to constantly fluctuate between too cold and too hot - would have added €864 to his 2014 energy bills. Against this scenario, the retrofit is delivering a whopping €2,500 saving per year. Depending on whether the 2014 or current low oil prices are used, and on whether the house is compared against an under-heated or 20+C house, the estimated payback ranges from 5 to almost 11 years.

1960s semi-d passive house retrofit

Heat pump running costs: €190/yr

When Ciaran Ryan and Mary Hodkinson went house hunting in Galway they were so committed to deep retrofit that they asked an architect friend – Passive House Plus columnist Simon McGuinness – to help pick a house that might lend itself to the process. Designed by McGuinness, the eventual retrofit to a 1960s semi-d in the Galway suburbs is about as radical as a retrofit gets: the 142 sqm house was gutted, reconfigured and upgraded to full certified passive house status in the process. The upgraded house is solely reliant on a Thermia air-to-water heat pump for space heating and hot water, installed by low energy specialists Heat Doc.

While passive houses tend to have unusually low running costs, the measured energy use in this house is nonetheless impressive. The metred usage for Ciaran, Mary and their two grown-up children in the home's first year (or year and three weeks, more precisely) post retrofit was just 3,658 kWh – 1,445 kWh for space heating, and 2,213 kWh for hot water. The house, which was featured in detail in issue 11 of Passive House Plus, cost an estimated €190 for heating and hot water in its first year. While the space heating part of that is an eye-wateringly low €55, such a figure owes greatly to the building's extremely energy efficient fabric. In this case it's arguably the hot water production where the heat pump earns its stripes – and a cost of €127 per year and €7 of immersion use isn't too shabby.

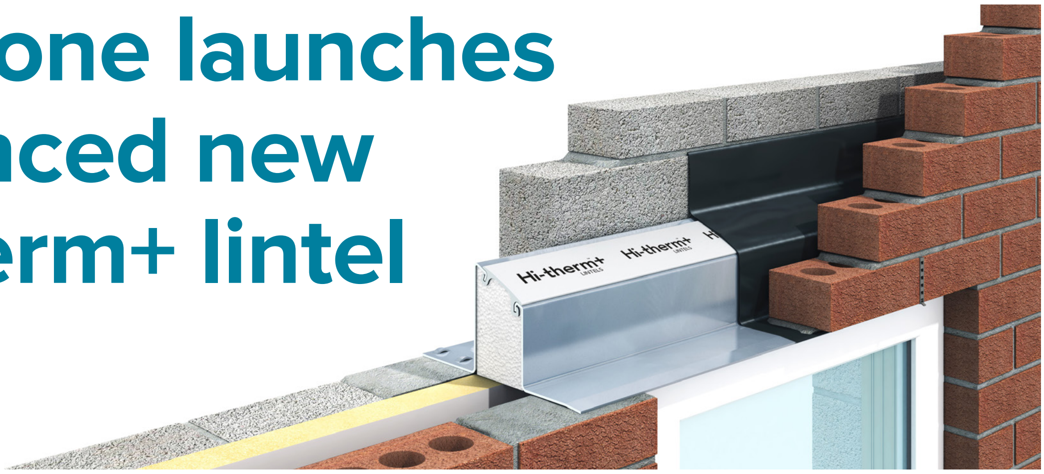
Next issue...

The PH+ guide to: ICF

Insulating concrete formwork is growing in popularity as people adapt to the requirement to build highly insulated, airtight, thermal bridge-free buildings. This guide will give an overview of ICF, analysing it in terms of thermal performance, buildability, fire safety, acoustics, structure and life cycle analysis.

Marketplace

Keystone launches advanced new Hi-therm+ lintel



Keystone's Hi-therm+ lintel, which the company claims will virtually eliminate what is often the most significant non-repeating thermal bridge in buildings.

Keystone has announced the launch of a new advanced version of its award winning Hi-therm lintel. Hi-therm has won multiple awards for innovation, and Keystone said that its design has now been upgraded to offer "even greater practicality to builders and to extend its benefits to a wider range of projects".

The design of the new Hi-therm+ lintel, while still utilising a rigid polymer thermal insulator as an effective thermal break, now incorporates a steel inner and external leaf. The product is as thermally efficient as the original but is now similar to a standard steel lintel for simplified installation.

Richard Kinloch of the Keystone Group explained: "The need to address thermal bridging is becoming a mainstream requirement and is boosting the need for advanced thermally efficient lintels. Our R&D team has continued in its quest for perfection and the new re-designed Hi-therm+ lintel helps meet the growing demand onsite for compliance with Part L 2013 regulations."

Lintels are in most cases the most significant non-repeating thermal bridge in buildings, as traditional style lintels interrupt the line of insulation with a continuous piece of highly conductive steel. The patented Hi-therm+ design uniquely combines the low thermal transmission properties of a rigid polymer with the structural strength of steel, producing a lintel that practically eliminates thermal bridging and delivers important CO_2 savings within SAP, thus enabling compliance with regulations.

Keystone said that Hi-therm offers builders a high performance lintel which can be handled and built on site in exactly the same way as standard lintels. "Split lintels and other non-structural thermal breaks are not comparable in terms of buildability and do not offer the simplicity of the Hi-therm lintel," the company said. "Hi-therm+ takes this practicality to a higher level again, making it even easier to handle on site than before. This addresses the challenge of maintaining good detailing when skill levels are under pressure and introducing specialist techniques can be problematic." ■

ECON Polyurethanes launch new, greener spray-foam insulation

ECON Polyurethanes have recently launched the new BASF Elastospray LWP (low warming potential) spray-foam insulation system to the UK and Irish markets. According to BASF, Elastospray LWP "combines maximum insulation performance with the best possible environmental protection".

The material is suitable for almost all areas of the building envelope, and delivers "low thermal conductivity owing to its closed-cell structure and airtightness while permitting insulation without thermal bridges," said a statement from BASF.

BASF Elastospray LWP delivers simple and fast installation, high compressive strength, and water vapour permeability.

In its bid to curb climate change, the European Union is aiming to drastically reduce the use of fluorinated gases (F-gases) with high global warming potential (GWP). The associated EU regulation is targeting a two-thirds cut in F-gas emissions across Europe by the year 2030.

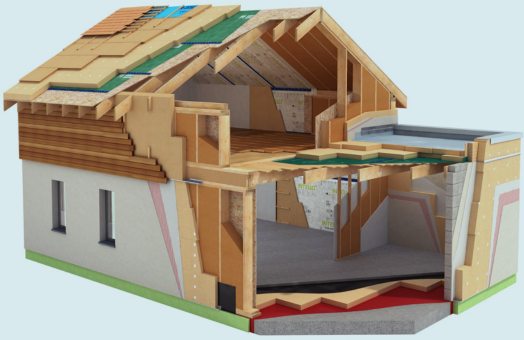
For industry, this means substituting hydrofluorocarbons (HFCs), conventionally used as blowing agents in high density spray-foam insulations, with eco-friendlier alternatives, and BASF has been a leader in this drive.

BASF Elastospray LWP has a GWP of just one, as well as zero ozone depletion potential.

"Climate change ranks among the biggest challenges of our time. At BASF, it is our endeavour to continually develop new products that support reductions in greenhouse gas emissions and sustainable resource use," explains Jesper Bjerregaard of BASF.

For more information see **www.walltite.basf.ie**. ■

(above) BASF's Elastospray LWP (low warming potential) spray-foam insulation, available throughout the UK and Ireland via ECON Polyurethanes.



Ecological announce 'Ecobuild 2 nZEB' course

Building on the success of its award-winning Passive EcoWall concept and range of low energy training courses, Ecological Building Systems has announced the launch of its new 'Ecobuild 2 nZEB' one day course. This workshop will provide step-by-step instructions on building a new home with ecological materials, and using passive house principles, to meet nearly zero energy building (nZEB) standards and ensure a healthy home for life.

Darren O'Gorman of Ecological states: "Any building completed after the 31st December 2020 must achieve nZEB standards, irrespective of when they were started. As the construction industry and building regulations are evolving so rapidly and moving to nZEB, now is the time to gain the knowledge on how to meet these high levels of building performance."

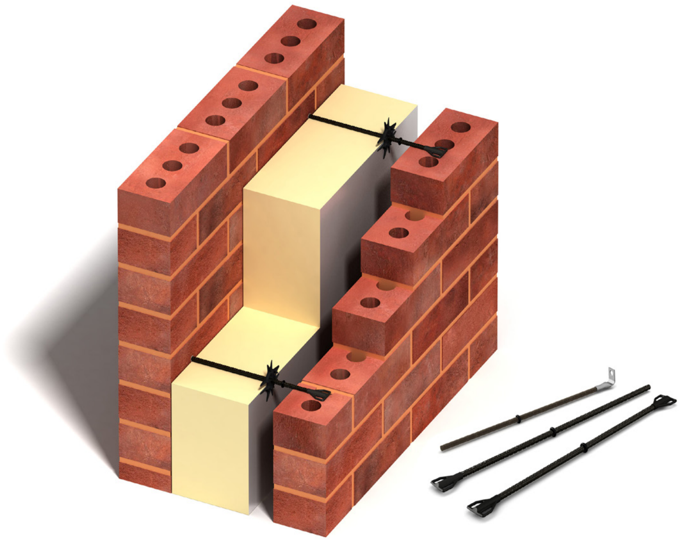
The course will comprise three parts and is focused around a virtual building model. The morning will focus on design considerations including an introduction to DesignPH and PHPP, Part L compliance & Deap assessments, passive house certification and Home Performance Index (HPI) certification.

The second part will investigate the insulated fabric in detail, while examining a range of assembly options for walls and roofs. Participants will be challenged with solving some thermal bridge-free details. Foundation junctions, roof eaves, window installations and door thresholds will also be examined.

The final part of the day will focus on airtightness and ventilation in new construction, concluding with a tour of Ecological's training centre and a blower door demonstration. On completion of the course each participant will receive a certificate of attendance and unlimited access to an online knowledge platform which will include: construction details in CAD and PDF, junction thermal bridge assessment, BuildDesk U-value calculations, a pre-completed Deap assessment file, a preliminary PHPP file for the model house, sketch file & plans of the model house, Passive EcoWall & EcoRoof U-value and quantities calculator. All of this will be provided for €95.00 per participant, including lunch.

'Ecobuild 2 nZEB' will be delivered at Ecological Building Systems state-of-the-art training centre in Athboy, Co Meath during 2018. For more information regarding the course and upcoming dates, email: **info@ecologicalbuildingsystems.com**. ■

Ancon to launch new products at Ecobuild 2018



(above) Ancon's Teplo building tie range, which will feature new variants at Ecobuild 2018.

Ancon will be launching its latest fixing innovations at Ecobuild between 6 and 8 March at the London ExCel centre, at stand number C62.

Ancon's Ecobuild stand will focus on structural fixings that are opening up new possibilities in zero and ultra-low energy construction by minimising thermal bridging, including its insulated balcony connectors and ultra-low thermal conductivity cavity wall ties. The stand will also showcase a brick-faced support system that allows designers to achieve "exciting masonry facade aesthetics, quickly and easily on site".

Heading up the displays will be Ancon's BBA-approved, multiple award-winning Teplo wall tie range. Manufactured from pultruded basalt fibres set in a resin matrix (0.7W/mK), a material over sixty times more thermally efficient than steel, Teplo ties are widely specified in passive house and other low energy developments.

The stand will feature new Teplo variants. Firstly, Teplo wall ties for use with Ancon 21/18, 25/14 and 28/15 Channels and secondly, the Teplo-BFR, featuring a plain end for resin-fixing into an existing structure and a moulded safety end for building into a new masonry leaf – making it ideal for retrofit. Both product ranges will break new ground in the masonry fixings sector, Ancon said.

Also under the spotlight will be Ancon's comprehensive range of insulated connectors designed to limit heat loss at balcony locations. Now engineered to carry even greater loads, the latest Ancon steel-to-concrete connectors accommodate large cantilever balconies and situations where connections are limited due to rebar congestion or column layout.

Ancon's Nexus system will also be displayed as part of the company's extensive brickwork support and restraint product portfolio. This modular brick soffit system, installed in a fraction of the time of a cast concrete alternative, was developed in association with prefabricated brickwork specialist, Ibstock Kevington. It combines a light, fully adjustable, brick-faced unit with Ancon's trusted bracketed brick support angle. Available in any brick type, Ancon claim the new system is perfect for creating modern architectural brick details, such as deep soffits, reveals and flying beams, quickly and easily, and blends seamlessly with the wider facade. ■

Viessmann boilers keeping visitors warm at revamped Postal Museum

(above and inset) Passengers on the Mail Rail at the UK Postal Museum, which has a new six zone exhibition space heated by a cascade of six 49 kW Vitodens 200-W gas condensing boilers.

Viessmann boilers have been specified for the revamped Postal Museum, which has recently opened its doors to visitors after a major £26m redevelopment supported by the Heritage Lottery Fund.

The museum's home, Calthorpe House in Farringdon, London, is now equipped with six 49 kW Vitodens 200-W gas condensing boilers combined in a cascade for a total maximum output of 294 kW. These provide warmth to the museum's new 500 square-metre exhibition space, which is divided into six zones.

Viessmann's recently-launched cascade system allows anything from two to six wall-mounted or floor-standing boilers to be combined, has three adjustable settings to accept differing boiler heights, and can accommodate the 49, 60, 80 and 99 kW models from the Vitodens 200-W range. The system requires 30% less space than its predecessor, making it ideal for plant rooms with a small footprint or limited headroom, and is suitable for row, block, or corner installations. Installation time is halved, thanks to an easy-assembly frame and fully pre-assembled heating circuit connection set.

Calthorpe House was formerly a Royal Mail administrative office and factory with exhibition and archive areas. Work on the building has included replacement of the roof, construction of an extension, and demolition of walls and floors to create larger open spaces. The new exhibition spans five centuries of history about 'the world's first social network — the post' and covers everything from ground-breaking design and quirky technology to the intimacy of personal letters.

Part of the Postal Museum is the Mail Rail, where visitors will be able to take a 20-minute underground ride through tunnels and station platforms previously hidden from the public, on a line which linked six sorting offices with the mainline stations at Liverpool Street and Paddington. ■

VictorianSASH windows revitalise historic Portsmouth home

A Victorian terraced home in Portsmouth is the latest retrofit project to feature VictorianSASH triple glazed timber windows from Eksalta, which resemble traditional sash windows while delivering modern high-performance standards of insulation and airtightness.

The windows were installed at the home of passive house consultant Rachel Mitchell, of Portsmouth-based architecture and engineering consultancy Greenbox Associates.

Writing in a blog post on her website, Rachel said she was keen to replace the existing uPVC windows at her house, which were fixed into the original sash boxes, because they were ugly and draughty, and because the two rooms they were in were damp and cold.

She writes: "I decided that I wanted sash windows to be in keeping with a Victorian house, but not necessarily sliding sash windows as you can get replacement windows that look like a sash but are not." Sliding sash windows are also notoriously draughty.

She was also keen on timber windows, even though she lives near the sea, because of the higher quality look and feel, end-of-life recyclability, and the ability to repair them if something goes wrong.

She wanted triple glazing too for a variety of reasons, particularly improved thermal comfort and less convection draughts around the windows. After much deliberation, she ultimately specified VictorianSASH triple glazed timber windows from Eksalta, which resemble a traditional sash window but have a fixed-upper window and tilt-and-turn lower unit.

"Eksalta provided the windows and Ainars Locs gave an excellent service measuring and making sure the windows would fit in the bays properly, as well as keeping an eye on the installation," she writes. "Recommended by Ainars, Oriel windows undertook the fitting and Shaun Rainbow managed to get the windows to fit in a not so square opening as well as patiently deal with my many questions."

To read more about the project, visit **tinyurl.com/victoriansash**. ■

Looks can be deceiving. Eksalta's triple glazed, airtight VictorianSASH windows have the appearance of traditional sliding sash windows.

SheepWool Insulation adds 'Ionic Protect' technology

Wicklow-based SheepWool Insulation has announced that its 100% sheep wool insulation and acoustic underlays are being treated with a new patented anti-insect technology called Ionic Protect, a 'plasma-ionic' treatment for its wool fibres.

Plasma processing is a common materials processing technology that aims to modify the chemical and physical properties of a surface using plasma. Plasma is one of the four fundamental states of matter, but unlike solids, liquids and gases, plasma does not exist on earth under normal conditions and can only be artificially generated by subjecting gases to heat or electromagnetic fields.

Plasma is generated when an ionised gaseous substance becomes highly electrically conductive to the point where long-range electrical and magnetic fields dominate the behaviour of the matter.

Passive House Plus recently spoke to the company to find out more about how this technology works, and was told that during the production process for SheepWool Insulation, the insulation is first scoured and cleaned, then it is processed to remove any plant matter and dust.

The wool is then processed into very fine layers which are drawn through a narrow slot where the plasma field is located. This changes the molecular structure of each wool fibre, so that they no longer provide nourishment for keratin-digesting insects.

Ionic Protect works immediately after treatment and is permanent. Because no substances are added, the wool can still be composted at the end of its life. Ionic Protect does not change the other physical and chemical properties of Isolenawool such as thermal conductivity, moisture absorption, formaldehyde absorption etc.

Under CUAP testing, moths and beetles ate 0.0g of the SheepWool Insulation and were dead after two months in a testing box with the wool, whereas for chemically treated wool, insects must ingest some of the wool first for the pesticide to be effective. ■

(above) SheepWool Insulation's Ionic Protect treatment, which has been proven to protect the wool against insects without the use of chemical treatment.

Balancing crucial to good MVHR function — CVC Direct

Leading ventilation supplier CVC Direct has emphasised the importance of ensuring mechanical ventilation with heat recovery (MVHR) systems are properly balanced to function correctly and efficiently.

"It is important that a system be designed, installed and commissioned correctly in order to ensure a balanced system," Nicolas Vaisey of CVC Direct told Passive House Plus. "If a system isn't balanced correctly, it can either pressurise or depressurise the house, resulting in an inefficient system. A balanced system should produce a neutral pressure within the building thus removing the risk of air leakage through the envelope of the building."

He explained that, if the extract rate is higher than the supply rate, there will be a negative pressure in the house, resulting in cold exterior air being drawn in through the leaks in the building envelope. If the supply rate is higher than the extract rate, there will be a positive pressure, allowing warm air to leak out through the building envelope. More importantly, the rate of heat exchange will be impaired if the supply and extract rates differ significantly.

Vaisey continued: "In the colder months, when the exterior air is below freezing, a system requires some form of frost protection in order to prevent the heat exchanger from freezing. The issue arises when the condensation from the extracted air is cooled by the external freezing air, the condensate freezes and blocks the channels in the heat exchanger."

Most units incorporate some form of frost protection function to protect the heat exchanger from freezing. This is often achieved by slowing the supply air fan which results in an imbalance of air flow and has the effect of seriously reducing the amount of heat recovered.

If this function is used for long periods, the house will get insufficient supply air, Vaisey explained.

By contrast, he said CVC Direct's range of Brink MVHR units have a completely new intelligent frost protection system which ensures that at low outdoor temperatures the unit's performance remains optimal and that, if necessary, it activates a standard preheater. The preheater provides sufficient amount of heat to the incoming air in order to raise the temperature to just above freezing. ■

Assuming no extraneous losses, at 90% efficiency
Extracted air at 20°C, Incoming air at 0°C
Temperature difference is 20°C.

Balanced system - for example 20° x 90% eff. means that the difference is 18°C
Exhausted air is now at 2°C (20-18)
Air supplied is at 18°C (0+18)

Unbalanced system - for example, extract side running at 50% of supply side.
20° x 90% x 50% = 9° difference
So exhausted air is now 11°C (20 - 9)
And air supplied is 9°C (0 + 9)

(above) CVC Direct calculation demonstrating the difference between a balanced and unbalanced MVHR system.

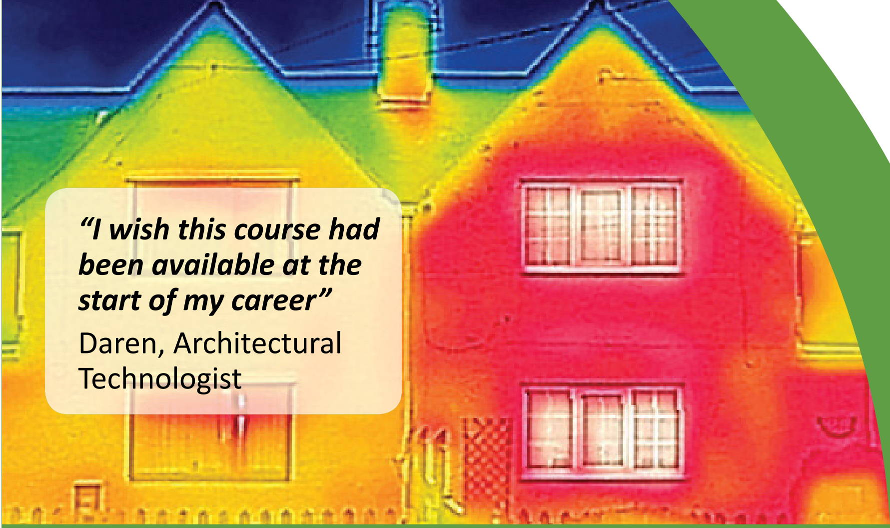
Green Building Store host free passive house & retrofit talks

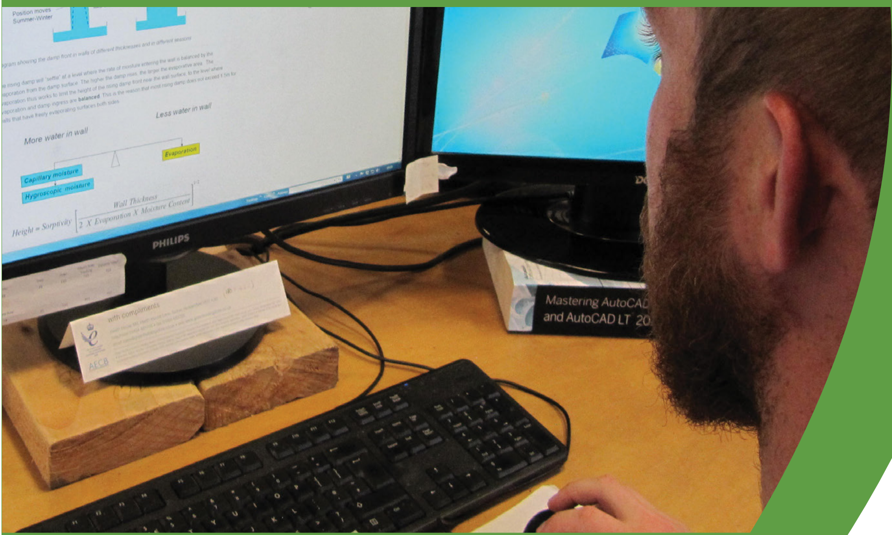
Green Building Store is running a series of open days throughout 2018 at its Yorkshire base in Huddersfield. The open days will offer visitors a chance to find out more about passive house and low energy new build and retrofit at a series of talks.

There will also be a chance to ask questions about projects and to look around Green Building Store's showroom, which features triple glazed timber windows and doors as well as mechanical ventilation with heat recovery (MVHR) systems.

The first dates planned for 2018 are Saturday 24 March and Saturday 21 April.

For more information see **www.greenbuildingstore.co.uk/huddersfield-open-days/**. ■





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THE MURKY WORLD OF

retrofit compliance

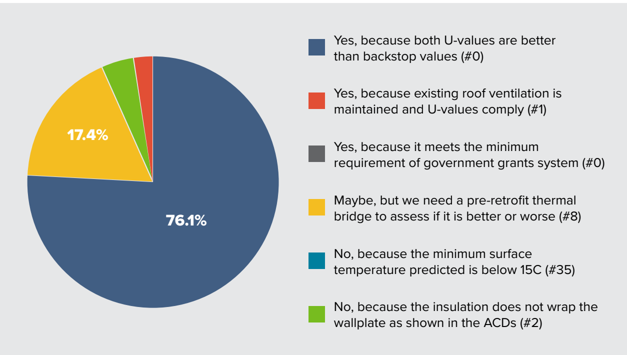
In his latest column, architect and lecturer Simon McGuinness of Dublin Institute of Technology polls 46 building professionals on whether a particular energy upgrade complies with the building regulations — with interesting results.

I was asked to advise as to whether a proposed upgrade of a house complied with building regulations. The 300mm rendered block cavity walls have been pumped with graphite enhanced bonded polystyrene bead. The roof has been insulated with 450mm of mineral wool at ceiling level. The existing ventilation of the roof at eaves level on both sides has been maintained. So far, so good, you might think.

However, a linear thermal bridge model at eaves level shows a surface temperature of 12.76C at the back of the cavity closer concrete block under the timber wallplate. Is this a problem? That turned out to be a very difficult question to answer.

Through my work at DIT, I polled 46 qualified Irish building professionals to see if their assessment concurred with mine. In most cases it didn't. In these complex areas, the answers are rarely black-and-white so I gave them a range of options to choose from. For this Helpdesk article, I would like to share with you the views of those building professionals and see if I can reconcile them with my own in the hope that I can point towards how such an apparently simple question should be answered. I suspect that many readers will find themselves faced with many such questions in the future and some may even want to review advice they may have already given.

The poll question asked was: "This is a thermal bridge calculation for a proposed residential retrofit with a pumped cavity wall and an insulated ceiling. Both wall and roof are lower than backstop U-values in Part L. Does the detail comply with building regulations?" The results are shown on the pie chart below.



Most professionals chose the response: "No, because the surface temperature predicted is below 15C". The next largest group chose the "Maybe …" option. Thus 93% of professionals agreed that the proposed upgrade, fully compliant with government guidelines, was in danger of contravening the building regulations.

Let's look first at the option no professional selected: 'Yes, because it meets the minimum requirements of the government's Better Energy grants system'. This seems to indicate a universal scepticism that government grants are awarded only to compliant building works. This should be a chastening finding for those who are responsible for spending public money wisely. It may also indicate a perceived quality deficit that will have to be overcome if Ireland is ever to persuade homeowners to invest in deep retrofit. The Bonfield Review in the UK identified similar barriers.

'Yes, because both U-values are better than backstop' was also avoided indicating an understanding that there is more to retrofit than just improving U-values. This is reassuring for me as it shows a shift in the professions towards a more holistic approach to retrofit than has been the case to date, or than is reflected in various government approaches to the design of market supports.

The addition of retained roof ventilation to that option found favour with just one building professional among the 46 sample. I suspect that this indicates a non-typical sample and that the ventilation and U-value combination would find favour with a majority of building professionals who have yet to upskill in nZEB technologies. For them, surface temperature factors remain a largely unexplored concept. That's a pity because any 'yes' answer to this question is wrong. Building regulations recognise that adding insulation can have negative impacts on condensation and mould growth in the vicinity of thermal bridges and that these need to be mitigated in energy retrofits.

> I polled 46 qualified Irish building professionals to see if their assessment concurred with mine. In most cases it didn't.

So that leaves two 'no' answers, both of which are wrong, albeit conservatively so. Firstly, there is no requirement to follow the ACDs (approved or accredited construction details) in order to achieve compliance. Compliance is demonstrated by implementing the ACD within strict limits, but it is not an exclusive means of so demonstrating. The 12.76C minimum surface temperature predicted is below the mandatory 15C in Ireland and advisory 15C in the UK, but this relates to new construction and material alterations. There is no requirement to increase surface temperature to the 15C threshold in an existing building where surface temperatures are below that threshold.

But what is important is not to make an existing non-compliant condition worse than it already is. This is where the 'maybe …' option comes in. If the insulation of the roof and wall cause greater infringement of the surface temperature factor than already exists, or an increase in the condensation risk at the thermal bridge, then the insulation works are non-compliant.

Unfortunately, the only way to assess that is to commission another linear thermal bridge model. As a rule, insulating planar elements often results in lower surface temperatures or greater condensation risk in the vicinity of untreated thermal bridges. These typically occur around windows and doors or at structural columns and beams. ■

HAVE A QUESTION YOU WANT TO PUT TO THE HELP DESK?
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